POWER

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Whom Do You Know?

AS ONE has among his books and other possessions some which he particularly values, so among his list of acquaintances there stand out some who are his friends.

The mind often reverts to them, impelled and directed by some subconscious impulse. Memories of them, thoughts of them, consciousness of them make, in large part, the background, color and atmosphere of our lives.

It is good to have a large list of acquaintances, as it is good to have a large library or a large assortment of other possessions.

Some men have a better faculty and better facilities for acquiring them than have others.

Some men the circle of whose daily life is very small have, within that circle, a wide knowledge of their fellow men and are known to them.

Others will go on a trip and come back without being able to recall any considerable number of people whom they have met and without having left any lasting impression along their trail.

The engineer has been criticised as being of this introspective type. He knows and works with materials as the salesman and man of affairs knows and works with men.

The smaller engineering practitioner especially has less opportunity to meet people and less occasion to cultivate them than have those in many other walks of life.

And yet opportunities are open. The reader of engineering literature has an acquaintance, one-sided though it be, with the leaders of thought and achievement in his profession.

If he thinks worth-while thoughts, observes intelligently and seeks interchange of ideas and information he can, through correspondence, through communication with and contributions to his vocational papers, through participation in the activities of his professional societies, extend his contacts, acquire acquaintances and develop friendships.

And when, in later life, he appraises his possessions he will find that among those that he prizes most highly are the friendship and esteem of the people whom he knows.

F. R. Low

POWER *Stands for . . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**

Competitive Bids for Engineering Services

THE practice of obtaining engineering service for public construction work by means of competitive bids is often as damaging to the construction work as it is to the engineering profession, and the desire of the American Association of Engineers to do away with this condition is commendable. As Dr. D. B. Steinman has said:

"What public official, about to have an operation, would invite the surgeons to submit bids? Legal services are determined by the best lawyer, not the cheapest one. Neither personal nor public property interests are expected to be defended on the competition-fee basis. And yet the engineer's responsibility in public projects concerns both the safety and the welfare of human life and the protection of property. In the medical and legal professions, standard fees prevail; these are based on training, experience, costs and services. Is it not illogical and unfair to refuse standard fees to the engineering profession —thus requiring the engineer to condescend to bargaining—where the training, requirements and services are as great?"

It certainly is!

The Power Plant Is a Part of the Business

POWER and other services in a large department store are a good example of what these may involve in large buildings. The power requirements may exceed one million kilowatt-hours per month and the steam requirements be more than one million pounds per day. Contrary to general belief, power generation, large as it is, may not be the chief responsibility of the engineering department. The transportation of the public and merchandise in a department store may involve the operation of eighty or more elevators and escalators, and a greater number of conveyors. The refrigerating plant, air-conditioning equipment, ventilating and heating and other systems may require more attention than power generation. These services and the power supply require yearly expenditures and a personnel that may exceed those found in a large industrial plant. Therefore, the opportunities for losses and savings are proportionately large. In Macy's plant, described in the leading article of this issue, the fuel bill alone is over $100,000 a year. A ten per cent increase in consumption, which could occur without the plant's operation becoming very bad, would amount to over $10,000 per year. But, in this plant, quite a different story can be told. The power generation in 1928 was twenty-five per cent higher than in 1924, but the plant's total fuel consumption increased only slightly over four per cent. This amounted to a saving in the fuel costs of more than $20,000 over what it would have been if the 1924 fuel rate had existed in 1928. Allowing for the better price at which oil was obtained last year the total fuel cost was about $12,000 less than in 1924.

These expenditures and savings in fuel alone indicate clearly why the management can well afford to take an interest in the supplying of power and other services. In the store under discussion, the assistant general manager is a graduate from the chief engineer's office and is directly in charge of all mechanical and electrical operations. In this way all these services come under an executive who is familiar with them and in a position to keep an intelligent check on their cost. In this organization the business executives realize that even if the power plant cannot make a profit, it can, if neglected, consume the profits made in other departments. Dollars saved in the power plant make just as good a showing on the credit side of the ledger as an equal amount of net profit made in a merchandising department.

Should the Plant Engineer Wear Overalls?

THERE are many engineers who while in the plant seem to find overalls a necessity. They typify a man who cannot bring himself to rely upon the judgment and capabilities of those working under him. They would like to superintend all important work in the plant and occasionally lend a hand when things do not go to suit them. Such engineers, continually puttering around with monkey wrench and pliers always in their pockets, can find little time for anything else.

Contrast them with the engineer who dons overalls only when necessity demands or for routine inspections of plant and equipment. This man places confidence in his operators, making them to a large extent responsible for the operation of the parts of the plant under their supervision. Relieved of problems that his assistants can solve, he can devote his time to the co-ordinating and administrative duties for which he is primarily employed.

The engineer in overalls tends to degrade his position, while the plant executive who seldom wears them makes his job more important in the eyes of his superiors.

Steam Pressures and Piping Costs

HIGH steam pressures are now "commercial" in the sense that an appreciable number of plants have adopted them for regular operation on a large scale in dollar competition with low-pressure plants. They are still "non-commercial" in that the manufacture of high-pressure equipment is not yet on a quantity-production basis. If, as is pretty well demonstrated, high-pressure stations can show a net saving under this temporary handicap, it is fair to assume that their future is secure. In this connection it is interesting to speculate on the ultimate cost of high-pressure piping and valves as compared with those of low-pressure plants of equal capacity.

It ought to be possible to get some idea of the ultimate cost relation by studying the effect of pressure on the weight of metal required. Consider, for example, the effect on piping of raising the steam pressure from four hundred pounds to sixteen hundred pounds. Within these limits the density of steam is roughly proportional to the pressure. For the same flow of steam in pounds per hour and the same velocity, the high-pressure line would need but one-quarter the internal area and one-half the diameter of the low-pressure line. Since (neglecting the "thick-tube" effect) the proper wall thickness is proportional to both the diameter and the pressure, the thickness would be doubled, giving practically the same weight of metal in both pipes. Ultimately this should mean about the same cost.

Much the same type of reasoning applies to valves, although the case there is not so simple. Again the change from four hundred pounds to sixteen hundred pounds would cut the areas of openings to about one-quarter and the internal diameters to about one-half. Body thickness would be doubled (approximately). Length would not change greatly. Bolts on flanges would carry practically the same total load in both cases. Gate-opening mechanisms would deal with substantially equal forces. All things considered, there appears no reason why the weight of high-pressure valves should differ greatly from that of low-pressure valves to handle the same quantity of steam.

This statement assumes, of course, that temperatures are not raised with pressures. The problem of building valves for high temperatures, such as the 1,000 deg. F. now proposed, is very difficult.

Leaving temperature out of consideration, it is reasonable to conclude that the ultimate cost of valves and piping to convey a given weight of steam per hour will not be greatly affected by the pressure. The cost *per kilowatt* may actually be reduced by high pressure because of the reduced weight of steam required to generate a kilowatt-hour.

Considering the total steam piping of a station, that in the high-pressure plant will certainly cost more if it uses reheating, while the low-pressure plant does not. If both reheat, the reheat piping and the total steam piping should ultimately cost about the same in both cases. Feed piping will, of course, cost more in the high-pressure plant, because water lines cannot be reduced greatly in size.

It appears that the only outstanding intrinsic burden of the high-pressure plant is the greater cost of the boiler unit. This is partly offset by savings in condensing equipment (due to less exhaust steam) and in coal-handling and combustion equipment (due to less coal burned). Certainly the problem of the high cost of forged boiler drums may find a partial solution, by direct attack or simply by finding a suitable substitute, within a few years.

Use Steam Twice, Where Possible

STEAM has been used twice in many ways for a long time. For instance, the exhaust steam from plant auxiliaries that is used to heat feed water is such a case. The exhaust of non-condensing engines or turbines which is used in heating systems, is used twice, once to produce power and the second time to furnish heat. The steam used in bleeder heaters on large steam turbines is another similar example.

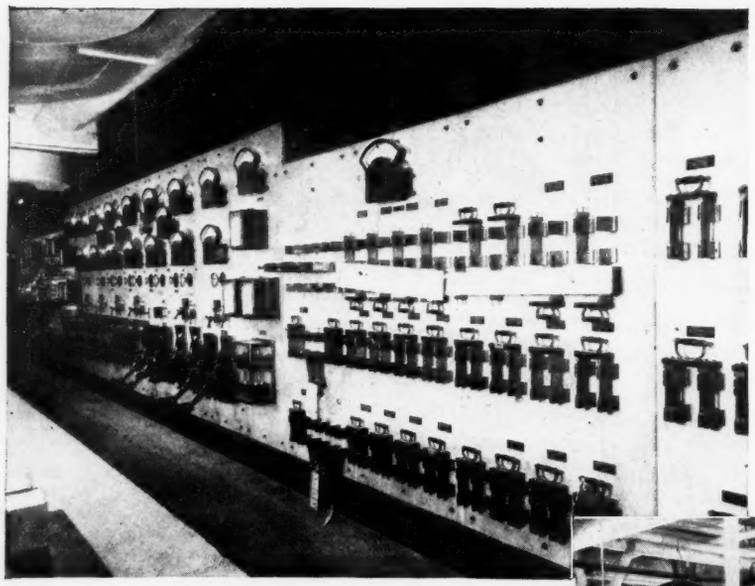
All of these examples refer to power station equipment. In general, the power plant engineer has realized the possibilities of such double use of steam and has utilized them to the greatest possible extent insofar as the power plant itself is concerned.

On the other hand, the possibilities of using steam twice are often entirely overlooked in industrial plants. Live steam is used in processes that could be served quite as effectively with exhaust or bled steam. Coal is often burned to furnish heat to dryers that would work quite as well with air heated by low-pressure steam. Numerous other examples could be given which indicate that an industrialist can often effect large savings by asking a power engineer to look over his plant and advise on the more economical use of heat as a by-product of power.

An excellent opportunity for using steam twice is presented in many industrial plants that buy power and still require considerable heat for process work. The installation of boilers with pressures of over four hundred and fifty pounds and of suitable non-condensing turbines or engines make it possible to furnish a large portion, if not all, of their powers requirements as a by-product of their process heating. This energy would be furnished at the rate of about one-third of a pound of coal or 4,500 B.t.u. per kilowatt-hour.

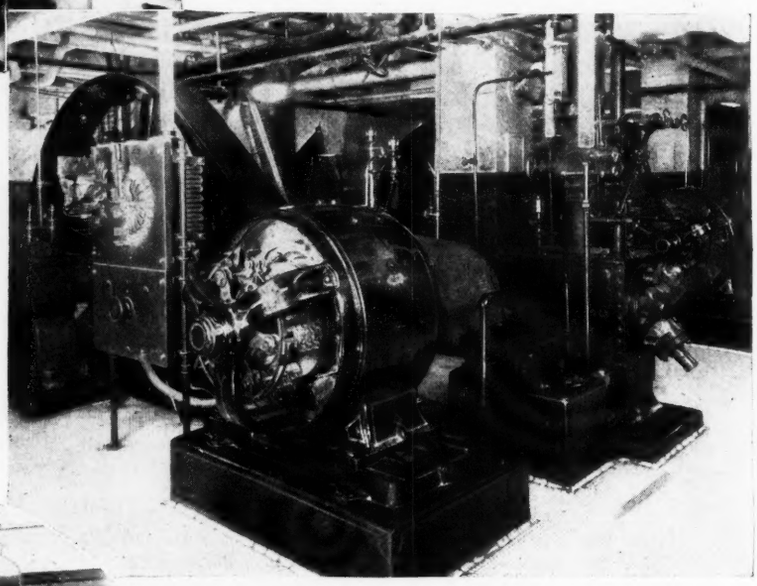
These thoughts suggest the idea that the final limits for the multiple uses of steam have not been completely developed and that many opportunities are still available where large savings may be effected by using steam twice.

An excellent slogan would be, "Use Steam Twice—Where Possible."

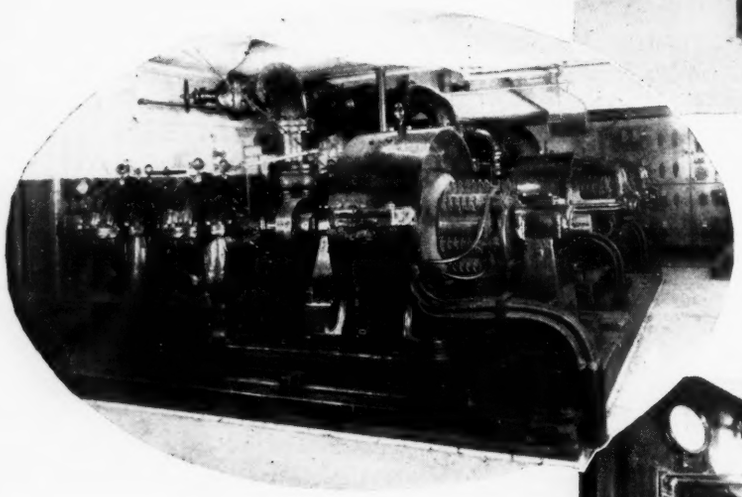


Left—Main switchboard, from which the seven generators are controlled and the power distributed to the different services. The circuits on the right-hand end of the board are being changed from two-wire to three-wire

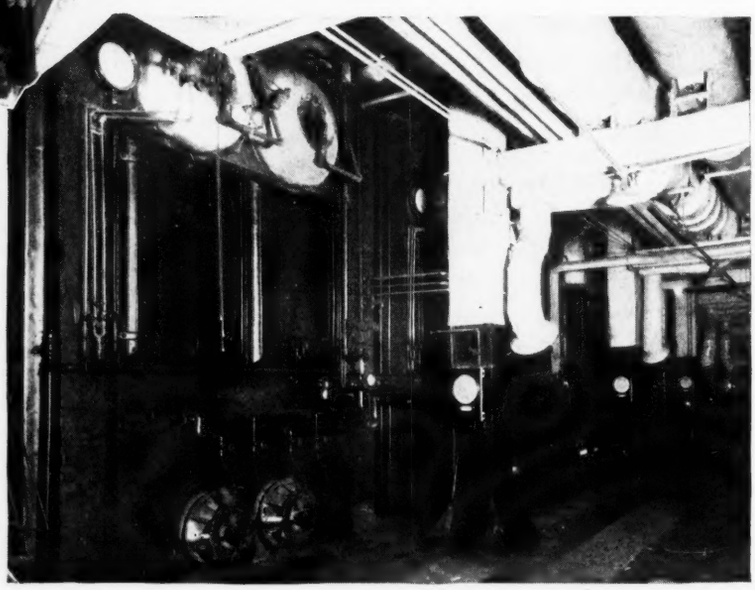
Below—Refrigerating plant has a capacity of 110 tons in three compressors. Three motors totaling 250 hp. drive the compressors through short-center belts with idlers



Views of Macy's Power-Plant Equipment



Below—Boiler plant contains eleven oil-fired 140-lb. boilers having a total heating surface of 30,000 sq.ft. For 1928 the average yearly boiler and furnace efficiency was 76 per cent

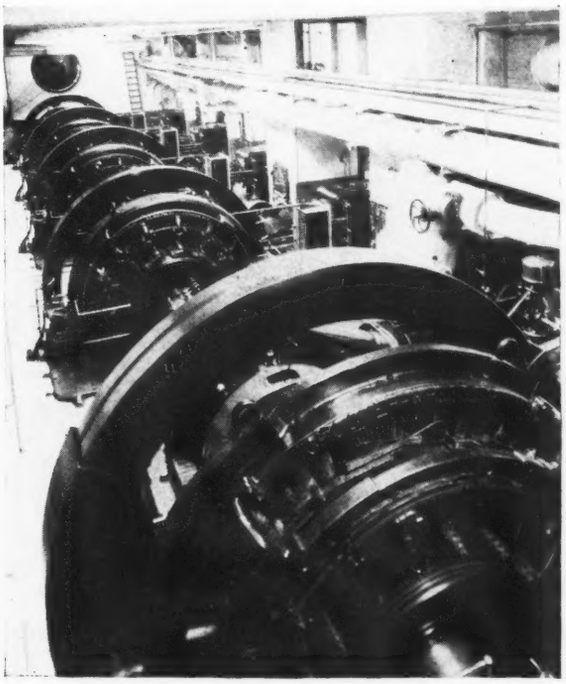


Above—Three motor-driven centrifugal pumps used on the hydraulic elevators. These pumps are being shut down to make room for future expansion of the power plant, and the hydraulic elevators are being replaced by electric machines

MACY'S POWER PLANT

Reduces Fuel Costs $20,000 a Year

This article tells the story of how the power and other services have been expanded to meet the requirements for one of the largest department stores. The boilers are oil fired, at an average yearly efficiency of 76 per cent. An economizer on rubbish incinerator saves $6,500 a year in fuel. Power increased 25 per cent in four years, with a fuel increase of 4.3 per cent. Two 333-ton refrigerating machines driven by exhaust-steam turbines condition air on ground floor and first basement.



Generating equipment totals 3,350 kw. in seven engine-driven units

EIGHT years ago when R. H. Macy & Company considered enlarging their department store at 34th St. and Broadway, New York City, they started a program of power-plant changes and expansion that is now nearing completion. This plant is one of the largest used in a public building. It supplied 9,434,000 kw.-hr. in 1928 to the store's power and lighting services. There was also supplied last year to the various heating services about 130,000,000 lb. of exhaust steam at nearly atmospheric pressure. This exhaust represents about 40 per cent of the total from the engines driving the generators.

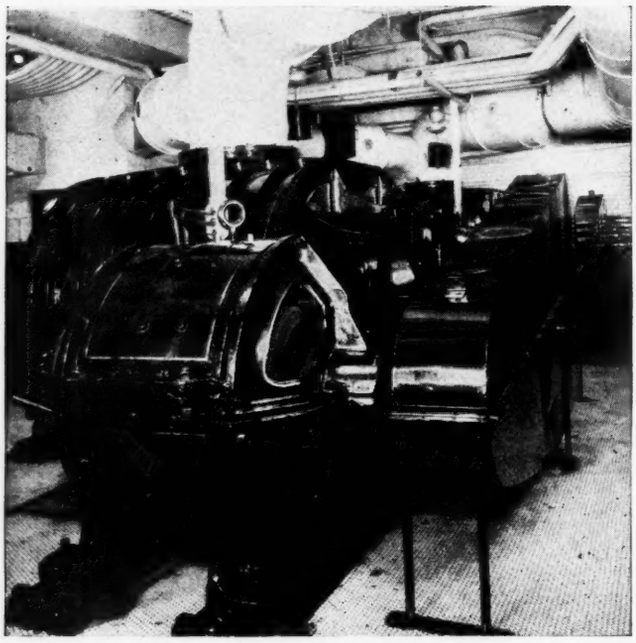
On the present basis of operation, the plant supplies a maximum load of about 3,000 kw. and generates about 20,000 kw.-hr. during an 8-hr. day shift and 35,000 kw.-hr. during a 24-hr. work day. About 50 per cent of the power is used for lighting and 50 per cent for power applications. The chief components of the power load are 40 escalators, 41 electric elevators, 1,000 hp. of motors on the heating and ventilating system, 275 hp. of motors on the air-conditioning system, 250 hp. of motors in the refrigerating plant, and 350 hp. on the pneumatic-tube system, and about 90 motors on the conveyor system.

The new building, constructed in 1922, added 450,000 sq.ft. of floor area to the store, giving it a total floor area of 1,550,000 sq.ft. When the expansion program was started one of the first problems to be solved was a power supply for the new building. In the sub-basement of the old building was a power plant of 2,000-kw. capacity made up of steam-engine-driven units and supplied with steam from eleven coal-fired water-tube boilers, having a total heating surface of 30,000 sq.ft. This plant was in excellent condition and gave good service as to economy and reliability, being able to generate power considerably cheaper than it could be purchased.

As a preliminary step, Werner Nygren, consulting engineer, New York City, was employed to study how best to expand the power facilities to supply the new building. This investigation led to a decision to enlarge the power plant. The first step in the program was to obtain more boiler capacity. It was found that this could be done by changing from coal to oil firing. The engineering investigation for the change was based on coal at $6.70 per ton and oil at four cents per gallon delivered. Estimates showed that with existing fuel costs, it would be possible to change from coal to oil firing and pay the cost of the change with two years' saving in operating costs.

A two-year contract was obtained for oil and the change-over made. The operating results have exceeded the estimate made in the engineering studies. Since the present contract for oil is considerably below the original price, the change-over has proved highly satisfactory. In addition to the reduction in fuel costs a saving of about $20,000 per year for labor and $4,000 for ash removal is obtained. Changing to oil firing also did away with the inconvenience associated with coal and ash handling and simplified the labor problem.

As installed for coal firing the boilers were set five feet above the grates. In the light of modern practice this would be considered too low, for coal and oil firing requires even a higher setting. Removing the grates gave about one foot increase in furnace height, but this



Blowers on the pneumatic tube system are driven by 150-hp. motors through silent-chain drives

was not considered sufficient. The boilers could not be raised in their settings, but another foot of furnace height was gained by blasting rock from the bottom of the combustion chambers. In the original plans it was intended to operate the boilers at about 150 per cent of normal rating. It was found that this could be done readily with high efficiency, but on account of the small furnace volume the brickwork was badly punished. Experience has shown that more satisfactory results are obtained by working the boilers at 125 per cent rating and operating more boilers.

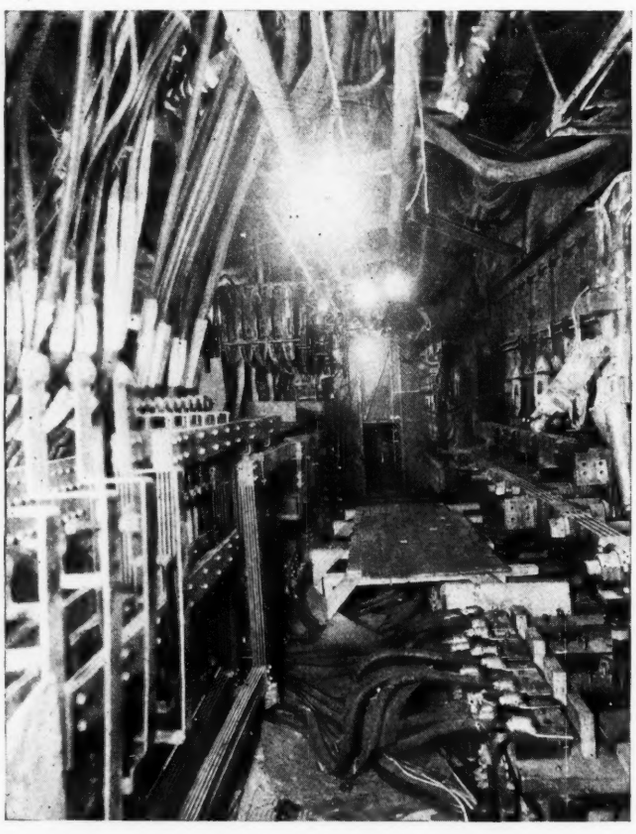
Along with the change in the boiler plant, plans were put into effect to increase the capacity of the power generating equipment. Kaiser, Muller & Davies, consulting engineers, were employed to make a study and recommendations for the new electrical system. These studies led to a decision to change from a 110-volt two-wire to a 125- and 250-volt three-wire system. This change presented a rather difficult problem, as the spare capacity in the plant was small and the new switchboard had to occupy the same location as the old one. Furthermore, the change-over had to be made with the normal load on the plant, and none of the services to the store were to be interrupted. It was also decided that the two-wire system of distribution in the old store was to be used on the new three-wire installation by distributing the circuits on the two sides of the system to obtain an approximately balanced load.

The first step in this change-over was to erect a temporary switchboard back of the old one and transfer all circuits to it (see picture on the right). This allowed rebuilding and enlarging the old switchboard for the three-wire system. While the circuits were being changed to the temporary switchboard and the new one installed, part of the 110-volt generating capacity was being changed to 250 volts.

The first change in this equipment was to remove two 200-kw. piston-valve engine-driven generators. This provided space to install a 750-kw. and a 250-kw. Corliss-engine-driven 250-volt generator. Three motor-generator three-wire balancer sets were also installed at this time. These were connected to the new switchboard and some of the 110-volt load transferred to them. The four 400-kw. 110-volt Corliss-engine-driven generating units being relieved of some of their load, one of them was taken out of service and rewound for 250 volts. When this machine was ready for service it was connected to the new switchboard and some more of the 110-volt load connected to the new system. This process was continued until all four generators were rewound and the 110-volt circuit transferred to the 250-volt three-wire system.

The entire change was made without an interruption to any of the services to the store. Some of the 110-volt circuits on each side of the three-wire system are connected to double-throw switches so that they may be connected to either side of system. By changing the switches the load on the two sides of the busbars is kept nearly balanced. At no time is it more than 100 amperes out of balance on an 11,000-ampere load.

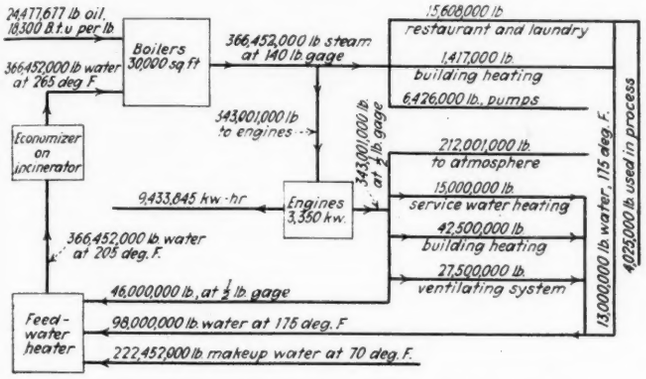
The engines driving the 400-kw. generators at the time of the change to 250 volts were 20 years old, but with the exception of the valves being worn a little were in practically as good condition as when installed. The question of whether the engines should be overhauled when the generators were being rebuilt was the subject of considerable discussion, with some of the engineers in favor of reconditioning them and some against it. To make the decision the manufacturer's engineers were called in and they recommended against overhauling the engines. Their efficiency was practically as high as could be expected, and the only improvement that could be had was a little quieter operating valve gear at light loads. Afterward it was decided, since the generators were being rebuilt, to recondition the engines even though they would give years of service before this would be necessary.



Back of the switchboard during the change from 110-volt two-wire to 125- and 250-volt three-wire system

Additional generator capacity was required to meet the increased power load that would result from the addition being built to the store. In the old store there were 26 hydraulic elevators supplied by two large high-duty reciprocating steam pumps. By replacing these pumps with motor-driven centrifugals, space was obtained to install another 750-kw. Corliss-engine-driven generator. This was done, giving the plant its present capacity of 3,350 kw., which is made up of two 750-kw., four 400-kw. and one 250-kw. units. All these generators are driven by Corliss engines.

The decision to use Corliss engines to drive the new


24,477,677 lb oil, 18300 B.t.u. per lb
Boilers 30,000 sq ft
366,452,000 lb steam at 140 lb gage
366452000 lb water at 265 deg F.
Economizer on incinerator
343,001,000 lb to engines
343,001,000 lb at ½ lb gage
9,433,845 kw-hr
Engines 3,350 kw.
366,452,000 lb water at 205 deg. F.
46,000,000 lb, at ½ lb gage
Feed-water heater
98,000,000 lb water at 175 deg. F
222,457,000 lb makeup water at 70 deg. F.
15,608,000 lb restaurant and laundry
1,417,000 lb building heating
6,426,000 lb. pumps
212,001,000 lb to atmosphere
15,000,000 lb service water heating
42,500,000 lb building heating
27,500,000 lb ventilating system
130,000,000 lb water, 175 deg. F.
4023,000 lb used in process

Approximate heat-balance diagram for 1928

In this diagram no account is taken of the various losses nor is credit given for hot water from drips to the feed water heater. All the high-pressure steam quantities are metered, but the low-pressure quantities are based on estimates made in engineering studies of the requirements.

generating units brings up an interesting sidelight on the much-discussed question of obsolescence. Four of the units in this plant are twenty-seven years old. These are in as good condition as when installed and, insofar as future developments indicate, will continue to be the most economical type of prime mover for this plant. When the new engines were selected, other types were considered. Some of the more modern types of engines have a slightly higher efficiency than the Corliss, but the latter were selected because they were considered to be the most reliable. In Macy's power plant, on account of the small reserve capacity, reliability is of utmost importance. The fact that new engines of the same type as the old were selected is the best indication that the old have not lost any of their original value as power-generating units in this plant. At any reasonable rate of amortization these engines and the boilers have long since been written off the books.

Building the addition to the store made inadequate the original facilities for handling the rubbish, such as waste-packing materials from the different departments. The storing and handling of this material had always been a serious problem. Waste paper was bailed and sold, but it was always a doubtful proposition economically. Then, the handling of this material at the loading platforms interfered with other shipments. In other words, this waste material was a sore spot in the smooth running of the store's regular business.

When new provisions had to be made to handle this material it was decided that the most satisfactory method would be to dispose of it immediately. This led to a decision to install an incinerator of sufficient capacity to burn all the refuse instead of only part, as previously done. Further study of the problem showed that considerable heat could be recovered by including an economizer in the incinerator and connecting it between the feed pumps and the boilers.

The economizer has been in operation for about five years, with highly satisfactory results. A pyrometer is connected into the furnace and the temperature controlled to maintain it at about 1,800 deg. F. With this temperature in the furnace, water entering the economizer at 205 deg. leaves at about 300. In other words, the economizer adds about 100 B.t.u. to each pound of feed water passing through it. On the present basis of plant operation this amounts to a saving of over $6,500 per year in the fuel bill.

The economizer is fired twenty hours a day. At 4 a.m. each day the fire is allowed to burn out and the furnace to cool, which takes about two hours. Then, the ashes and unburnable material are removed and firing started again about 8 a.m.

The store has had such an unexpected increase in business that the original incinerator no longer has a capacity sufficient to burn all the refuse, and a second unit has been installed to burn the excess. The first incinerator was installed to burn 1,600 lb. of rubbish an hour, but has burned as high as 6,000 lb. The new incinerator is fired chiefly during the rush seasons. Up to the present time no provisions have been made to utilize its heat. However, studies are now being made with this in view.

Last year the plant generated 9,433,845 kw.-hr., and this year the power production is much higher, running over 900,000 kw.-hr. per month. In 1928 power was produced at a cost of 1.603 cents per kilowatt-hour. In this cost are included all operating charges, such as fuel, rental for space occupied by the generating plant, salaries of the men employed in the generating plant, maintenance, lubricants and waste. No capital charges are included, for two reasons: First, they would not be included in a proposition to shut the plant down and purchase power; second, a major part of the equipment, as previously stated, is 27 years old and at any reasonable rate of amortization would be written off the books.

In the kilowatt-hour cost no credit is given to the exhaust steam from the engines for heating the building. If the generating plant had not been operated it would have cost about $35,000 per year for fuel oil alone to produce the heating steam supplied by the exhaust from the engines.

RÉSUMÉ OF PLANT'S OPERATION IN 1928

Total steam produced, lb.	366,452,000
Total fuel oil burned, lb.	24,477,667
Heating value of fuel oil, B.t.u. per lb.	18,300
Water evaporated per lb. of fuel, lb.	14.97
Boiler and furnace efficiency, per cent	76
High-pressure steam used for miscellaneous purposes, lb.	23,451,000
Total steam used in steam engines, lb.	343,001,000
Total kilowatt-hours generated	9,433,845
Cost, in cents per kilowatt-hour for fuel, labor, rent, maintenance anl lubricants	1.603*
Steam, at 140 lb. gage (no superheat), per kw.-hr., lb.	36.36†
Exhaust steam used for building heating system, lb.	70,000,000
Exhaust steam used for hot water, lb.	15,000,000
Exhaust steam for feed-water heating, lb.	46,000,000

*This cost does not include capital charges or any credit for exhaust steam used in heating the building and supplying hot water.

†This is a plant steam rate and includes all the losses from where the steam leaves the boilers to where the power is delivered on the busbars. Some of these losses such as pipe radiation are constant even when the engines are not in service.

Ever since 1924, the first year of oil-burning operation, the fuel per kilowatt-hour has decreased, although power output has increased. In 1924 the generating plant's output was 7,535,933, kw.-hr., and for all pur-

poses a total of 2,870,373 gal. of oil were burned. These quantities for 1928 were 9,433,845 kw.-hr. and 2,994,936 gal. of oil. This is a 25 per cent increase in power with only a 4.3 per cent increase in fuel. At the rate paid for oil last year the saving in fuel cost over the 1924 fuel consumption amounts to over $20,000.

This reduction in unit fuel consumption has been due to a number of causes, such as the economizer in the incinerator, a better load factor, replacing steam-driven pumps by motor-driven equipment, and to other changes.

A part of the rebuilding development for the addition to the store was to increase the capacity of the refrigerating plant. This part of the plant was changed from an absorption system of 50-tons capacity to a compression system of 110-tons capacity. The installation consists of one 50-ton and two 30-ton compressors driven by motors through short-center belts with idlers.

With the power and refrigerating plants as rebuilt and operated, last year about 45,000 cu.ft. (337,000 gal.) of water per day were required for boiler feed, condensers on the refrigerating machines and for building services. All the water used in the refrigerating-machine condensers is used for boiler feed and building services, so that none goes to the sewer.

The load has continued to increase on the plant until about 400-million pounds of steam per year are required for power generation, kitchen, laundry, pressing rooms and other services. An average of about 40 per cent of the exhaust from the engine is used for heating and hot-water services during each year. This leaves a large surplus of exhaust steam, particularly in the summer months, which goes to the atmosphere.

Air-Conditioning Plant

Plans have been under consideration for a number of years to condition the air on the ground and basement floors of the store. This project has recently been completed. To cool the air, two 333-ton refrigerating machines have been installed. After exhaustive study of the various methods available for driving the compressors, it was decided to install low-pressure steam turbines using the exhaust from the engines. Condensing water is taken from the city mains. This water first passes through the refrigerating-machine condensers before going through the steam condensers and to the sewer.

When the refrigerating plant is operating at maximum capacity, condensing water will cost about $90 per day. For the entire season this cost will be about $7,500.

As previously mentioned, the load on the generating plant has increased beyond all expectations. As a result, the exhaust pipe running to the roof is smaller than required for the present load and the back pressure is somewhat higher than it should be in the summer months. By installing the exhaust steam turbines, the back pressure on the engines has been reduced and their steam rate slightly improved.

Placing a cooling tower on the roof of the original store building was considered. This was decided against, as it would have required strengthening the building structure. The cost of doing this, along with the cost of the tower and pumping equipment and their maintenance, left little in favor of this proposition over that of discharging the condenser water to the sewer. Studies are now being made for an expansion program that when carried into effect will use a large part of this water.

The capital charges on a cooling tower for this installation would be high, since it must have sufficient capacity to take care of a maximum condition that exists for only a short period during each year. Then, for over 75 per cent of the days in each year it would not be in service.

The foregoing is, in brief, the story of Macy's store power plant *up to now*. Plans for future expansion are actively under way. This winter the plant will heat practically all the buildings occupying the same block as the store and will utilize all of the exhaust steam from the engines during a large part of the heating season and further improve the economy of the plant. The air conditioning plant went into operation on June 10th, and it will be described later in *Power*.

For the information in this article *Power* is indebted to John Cogan, assistant general manager in charge of engineering; Thomas Brennan, chief engineer; Werner Nygren, consulting engineer on all mechanical work; and Kaiser, Muller & Davies, consulting engineers on the electrical installations.

CO_2 Instruments Are Now in General Use, Survey Shows

AN INQUIRY into the percentage of plants using CO_2 instruments and boiler-water-level recorders was recently made by the prime movers committee of the National Electric Light Association. It was found that two-thirds of the member companies who replied are using some type of CO_2 instrument and, while all of them do not approve wholeheartedly of the equipment, the consensus of opinion seems to be that they are an aid to the fireman and useful in combustion control.

Chemical, mechanical and electrical types are in use. The chemical type is in the majority. This is ascribed to the fact that they have been on the market for a longer time. Where instruments other than the Orsat are used, they are practically all of the recording type, and many have, in addition, an indicator.

"The favored location," the report of the committee states, "is on the boiler instrument panel, but in some instances other locations, such as the boiler room engineer's office, have been chosen. Generally there is one instrument per boiler, though some plants have one instrument for a group of boilers."

It is the practice to check the instruments at regular intervals against the standard Orsat apparatus. The accuracy of the instruments, according to the report, varies within the limits of —.5 per cent to +3 per cent of the Orsat reading, and is fairly well maintained if the instruments are given reasonable care.

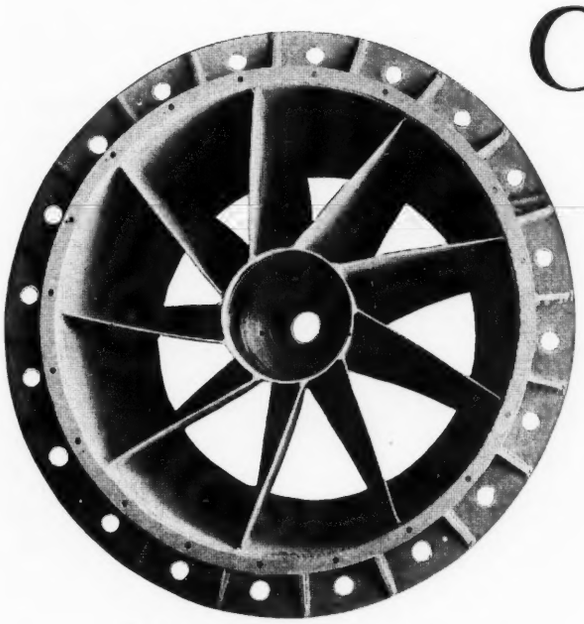
"Gas samples," it is stated, "are, as a rule, taken from one point at the center of the flue, though in several cases two or more points across the breeching are selected, and with few exceptions the gas is drawn through porous filters."

The maintenance cost varies from "very small" in one case and "one man-hour per day per instrument" in another, to "$4 per instrument per week" for a third, with all the gradations between.

Only a few installations of boiler-water-level indicators or recorders were reported. The instruments are said to be dependable and to require but little attention. They are checked by comparison with the boiler gas glass.

However, it is pointed out in the article that the replies "do not indicate that any of the members are giving serious thought at present to a general use of such instruments as a necessary or desirable adjunct to the regular water glass on the boiler drum."

Propeller-Type Blowers Cool HELL GATE GENERATORS



Guide vanes in the blower housing

Three of these blowers, driven by 300-hp. 3,250 r.p.m. squirrel-cage induction motors, supply 275,000 cu.ft. of air per min. to two 94,200-kva., at 0.85 power factor, generators

By L. N. THOMPSON

Engineering Department, Westinghouse Electric & Manufacturing Co.

THERE has recently been installed in the Hell Gate station of the United Electric Light & Power Company, New York City, unit No. 9, having a capacity of 165,000 kw. at 85 per cent power factor. This is a cross-compound unit, the high-pressure turbine being a combination impulse-reaction single-flow, and the low-pressure a straight-reaction double-flow machine. The two main generators are duplicates, and each has a rating of 94,200 kva., 3 phase, 60 cycle, 13,800 volts, 1,800 r.p.m. They require for cooling a total of 275,000 cu.ft. of air per min. at a static pressure of 15 in. of water. This air is supplied by three Westinghouse propeller-type blowers of 92,000 cu.ft. per min. capacity, each, which are driven by 300-hp. induction motors at 3,250 r.p.m.

The generators are arranged side by side, with a single duct covering both. The air coolers are directly beneath, and the three blowers are located between the generators. The air path through the generators, air coolers and blowers forms a closed circuit, the air passing upward through the blowers, down through the generators and coolers, and back to the blowers, as shown in Fig. 1.

Air discharged from the three blowers passes to a common chamber, and the distribution of this air to the two generators depends upon the similarity of the two air paths and on the divide just above the blowers.

In passing through the generators the cooling air coming from the blowers enters alternate open bays of the main generator stators, from which it flows radially inward from all points around the circumference through numerous small openings in the stator iron, thence through a short length of air gap and then radially outward through other numerous small openings into alternate bays, enclosed at the top, which carry it around and downward to the air coolers. Air also enters the air gaps, rotor end windings and rotor bodies from the end bells. Fig. 2 shows these air paths, an arrangement that has never been used before.

From the generators the air passes downward through twin six-pass air coolers. There is a total of eight cooler sections, four for each generator. The cooling medium is raw salt water taken from main condenser circulating pumps.

On leaving the coolers, the air passes through the dampers and enters the three blowers through three separate passages from each generator. These separate passages are combined in pairs into three common chambers at the blower inlets.

The blowers are of the propeller type and pass the air in an axial direction. A slight circumferential whirl is produced, which is straightened out by stationary guide vanes in the diffuser. The diffuser itself converts the kinetic energy of the air leaving the propeller into potential energy in the form of pressure at the exit. The blower housing with the guide vanes is shown at the top of the first page. This is of built-up design fabricated throughout and arc welded, as are also the propeller, complete main motor frame, oil reservoir and damper-operating cylinders.

A view of the complete rotating element assembled, including the propeller, shaft, and motor rotor, is shown in Fig. 3. Each blower has three bearings, two of which are in the motor and one supported in the central portion of the blower housing. The blower housing is supported on Korfund pads, as indicated in Fig. 1, while the main motor is supported by a hanging platform at a different level. On account of this, the upper, or blower, bearing is provided with a spherical seat to allow a slight movement of the motor relatively to the blower housing without causing binding in the bearing. Korfund is a cork composition material.

A comparative study of the stresses in propeller blades

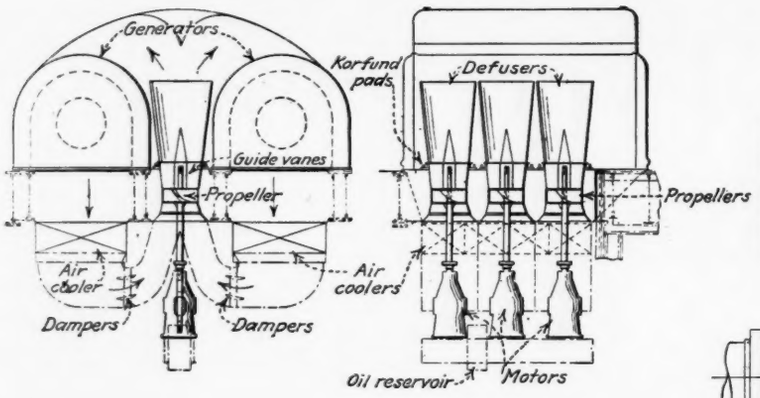


Fig. 1 (Above)—Outline of blowers, generators and air coolers

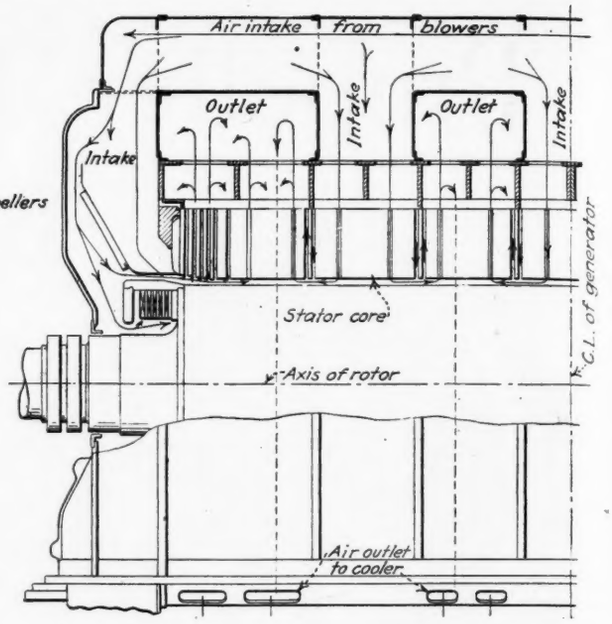


Fig. 2 (Right)—Air paths through generator

of various cross-sections is given in Figs. 4 to 7. Fig. 4 shows a section of and stresses in a blade of uniform thickness from root to tip, such as has commonly been employed in propeller-type blowers. It will be seen that such a blade has a maximum stress at the root of 54,600 lb. per sq.in. It is obvious, however, that if the blade were tapered down from root to tip, the stress would be materially reduced. The limiting case for such tapering, in which the blade tapers to zero thickness at the tip, is given in Fig. 5. In this blade the stress at the root has been reduced to 19,400 lb. per sq.in. However, in actual practice the blade must have some finite thickness at the tip, the amount depending on the size of the blade. A thickness of $\frac{1}{8}$ in. is not unreasonable for the propeller under discussion. A blade with a straight taper from root to tip and a tip thickness of $\frac{1}{8}$ in. is shown in Fig. 6, the stress at the root being 23,400 lb. per square inch.

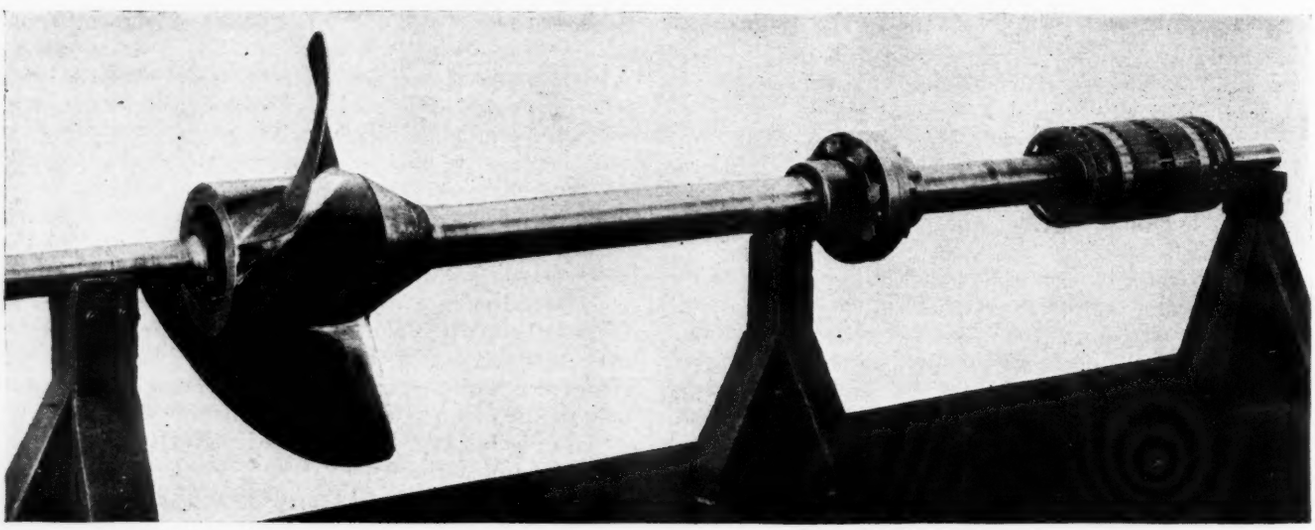
A blade whose cross-section is curved will have a lower stress than one whose cross-section is a straight taper. The curved-sided cross-section gives the lowest possible stress at the blade root provided it is possible to maintain uniform stress at all points. While this is not possible, the case of uniform stress is approached in the section, Fig. 7, which consists of three straight-sided tapered sections joined by curves of large radii. This section involves a maximum stress at the blade root of 17,500 lb. per square inch.

All the stresses in the diagram are calculated at 20 per cent above normal speed, or 4,320 r.p.m., all propellers having been run to this speed on test.

These curves also indicate that in order to avoid serious concentration of stress, it is necessary that the blade, when actually made, should conform closely to the design contour at all points. To accomplish this result an entirely new method of producing propeller blades had to be devised. Forged disks of 5 per cent nickel steel, heat treated, were turned into rings having a cross-section as in Fig. 7. In finishing the rings great care was taken to remove all scratches, the surfaces being polished all over on both sides. They were then cut into segments of the correct size to form the blade blanks.

These blanks were heated in a non-oxidizing atmosphere to about a cherry red and warped to the required shape between dies. It should be noted that this was not a forging operation but only one of bending, and hence the cross section of the blades was the same after bending as before they were subjected to the forming process.

Fig. 3—Rotating element, showing propeller, motor's rotor and shafts



After this, two blades were assembled to each hub and located by means of a jig, which insured that they were exactly 180 deg. apart and both set at the correct angles. They were then tacked in place, after which the welding to the hub was completed. Fig. 10 shows a section through the hub with one blade section in place before welding.

Fig. 8 gives the shape of the welded blade fastening. The maximum shear stress in the weld occurs at section *A-A*, and is 8,300 lb. per sq.in., and the maximum combined stress at section *B-B* is 9,400 lb. per sq.in., both at 4,320 r.p.m. The completed propeller before final machining is shown in Fig. 8, and its location is indicated in Fig. 1.

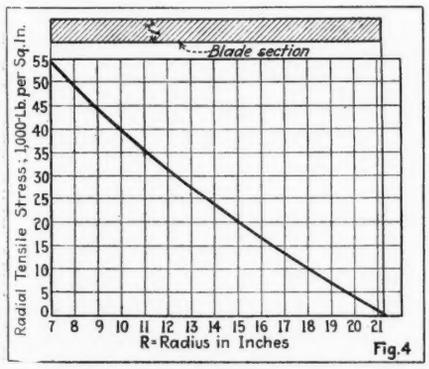
The main driving motors are of the squirrel-cage induction type, rated at 300 hp., 2,300-volt, 3-phase, 60-cycle, 3,520-r.p.m. The motor base contains a Kingsbury thrust bearing, which carries the entire weight of 3,000 lb. of the rotating element. The thrust bearing collar is also the oil impeller, which serves as a main oil pump for the lubricating system. The motor and the welded construction of the frame are shown in Fig. 11, and the motors are located as in Fig. 1.

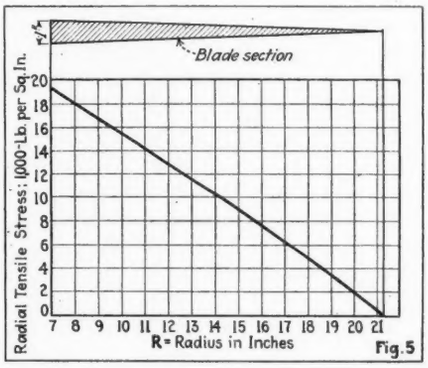
All three bearings on the unit are easily removable. The upper bearing in the blower housing slips off the end of the shaft, the middle bearing is built in halves, and the lower bearing slips off the end of the shaft after the thrust-bearing cover and oil impeller has been taken off. The upper bearing is mounted in a spherical seat and the other two have cylindrical seats. All bearings have cast-bronze shells with babbitt linings. As in Fig. 1, the three blowers are supported on a plate between the two main generators. Their housings are carried on Korfund to eliminate vibration.

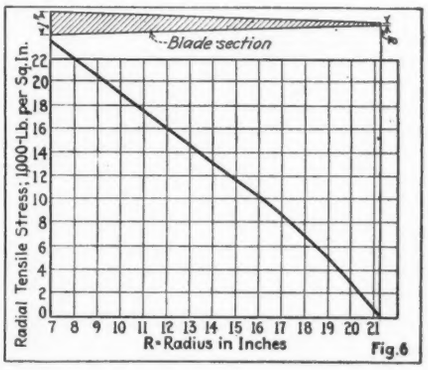
The blower units have a separate oiling system of their own. It was necessary to place the blowers so low with respect to the main unit that the returning oil could not drain back to the main oil reservoir, and it was deemed unwise to depend on artificial means of putting it back. Each blower motor has an oil impeller, which, after the blower has attained two-thirds speed, supplies oil to the bearings and to the relays for operating the dampers. While the blower is at rest or running at any speed up to two-thirds normal, oil is supplied to the bearings and relays by an auxiliary oil pump. Properly placed check valves automatically cut this pump in and

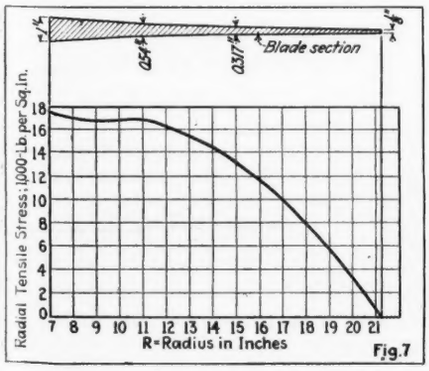
Fig. 9—Propeller after blades have been welded to the hub

out. The oil is fed to the bearings and relays under pressure, but drains back to the reservoir, shown in Fig. 1, by gravity. The drain passages are amply proportioned to pass the oil at all times; but to make doubly sure that no oil will overflow the baffle tube at the upper bearing and get into the generator windings, oil ejectors are supplied to assist the flow in this particular drain line. These ejectors are of such design that in case the high-pressure supply nozzle gets plugged, there is still









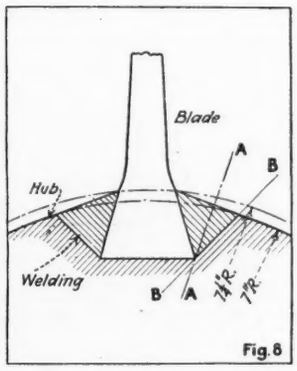


Fig 4—Blade-stress curve and blade section of uniform thickness

Fig. 5—Blade-stress curve and blade section of uniform taper and zero thickness at tip

Fig. 6—Blade-stress curve and blade section of uniform taper and $\frac{1}{8}$-in. tip thickness

Fig. 7—Blade-stress curve and blade section of varying thickness and $\frac{1}{8}$-in. tip thickness

Fig. 8—Section through the weld of blade fastening

a generous passage for draining away the oil. Oil coolers are provided to maintain a proper temperature in the system.

In the air path to each blower there are dampers which are automatically closed when the blower comes to rest, are opened when the blower reaches two-thirds full speed, and are closed again if the blower is shut down. This not only enables the main unit to be operated with

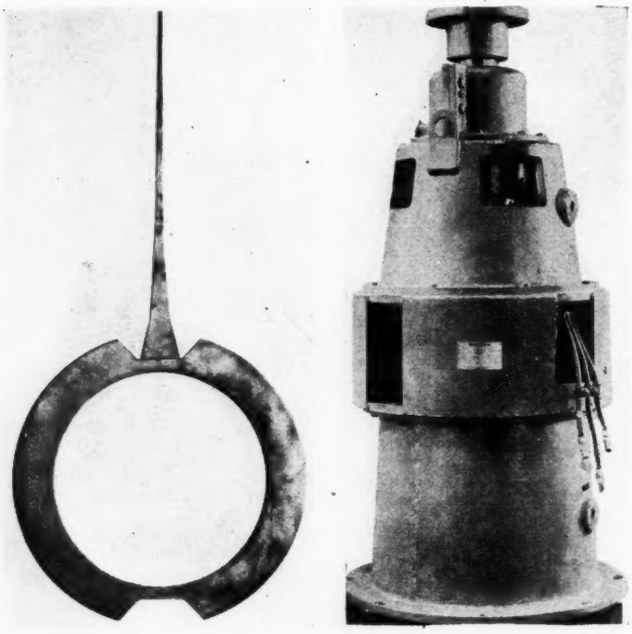


Fig. 10—Section through hub and blade before welding
Fig. 11—One of the blowers' motors, rated at 300 hp. and 3,250 r.p.m.

one or two blowers down, but any one blower is cut in or out at just the proper time when starting or stopping. The dampers are operated by relays, and operating cylinders by means of oil pressure supplied by the main and auxiliary oil pumps.

As originally built, the blowers were somewhat over capacity, and it was necessary to make certain changes to reduce the capacity. These changes lowered the efficiency somewhat. The final shop tests showed a static efficiency of the blower alone of 76 per cent, or a total overall efficiency, including the effect of air velocity at exit, of 81 per cent.

Need for Accuracy in Power Plant Records

By Leslie D. Cronin

After following the engineering profession for nearly twenty years, I have at last reached the conclusion that the engineer and the fisherman should join forces when the question of their skill is brought up; for in that time I have encountered many records left by engineers in plants where they have been employed that would put to shame the average fisherman when it comes to a question of truth.

Much has been written as to the necessity of keeping records, and numerous sample forms have been shown in the various engineering publications in an effort to educate the engineer; but so far I have yet to read an article that stressed the need for accuracy. The records that an engineer leaves behind him in a plant often are called into use, and those who follow him base their judgment of his ability upon the accuracy of such records.

In my opinion, the basic reasons for inaccurate records are two particular types of engineers: The one who is honest but easy-going and who just tries to keep things running smoothly and does not want to take the trouble himself or bother his help to see that the records are honestly kept as long as the wheels are kept turning; and the other, who, in an effort to impress his employer with his great ability, deliberately falsifies his records to show a low operating cost. The latter type is the greatest enemy of the average engineer in charge of plants, for when the employer learns that these records have been padded he will be a long while accepting any other engineer's records as accurate.

Now, when I speak of records I do not necessarily mean that this applies only to the plants having equipment which enables them to carry their power-plant cost figures to the last hundredth of a cent. I also include the average factory plant that has not the equipment and has to arrive at cost figures by more or less laborious methods. Of course, in the larger power houses, delivering electrical power to their switchboards to be sold to the consumers, and having elaborate checking systems for their heat-balance cycle, the possibilities of either deliberate or accidental errors being placed on the permanent records are small. But in the manufacturing plant, delivering heat and power and processing steam, the possibilities are great.

Some years ago I took charge of a large manufacturing plant and, as usual, started out to locate the records of past performance. It took me only a short time to find out that there were plenty of such records covering the former engineer's term of service with the concern. Imagine my surprise to find that according to the figures he had managed to obtain an average evaporation over the entire 24 hours of each working day of from 13 to 15 lb. of water, while using an average grade of soft coal under stoker-fired boilers. The plant engineer assured me that these figures were correct and that he could prove it by daily log sheets. Upon further inquiry as to how the daily figures were obtained, as there was no meter on the feed line, he told me that the city meter leading to the power house was used. As we had several air compressors and an ice machine taking off the same lines, I had no trouble understanding the reason for the figures. It took me some time to convince him that everything that come into the power house did not go into the boilers.

Another plant I took over carried on the books nearly 4,000 tons of coal supposed to be in storage on a large piece of ground near the plant. After looking up the figures and checking with the office I measured the pile and found that it was nearer 2,000 tons.

So now, after many such experiences, I have finally arrived at the conclusion that plant records and fish tales are the same. If an engineer is going to try to keep a set of records let him, for his own sake and the sake of the ones to come after him, try to have them as accurate as possible, and where he has to guess let him plainly mark such parts "approximate." If the average engineer were as jealous of his reputation in the matter of keeping accurate records as he is of being a good mechanic, there would be a vast improvement in record-keeping.

FLY-ASH NUISANCE

In Textile Plant

CURED BY FILTERS

By Charles D. Owen
Plant Engineer

In 1927 the power plant of the Acheson Harden Company, Passaic, N. J., was rebuilt to replace old equipment that had become obsolete. The plant furnishes power and heat for the mill, which is the largest source of handkerchiefs in this country. While the mill is not classed as a large textile mill, the power-plant equipment selected is characteristic of modern installations.

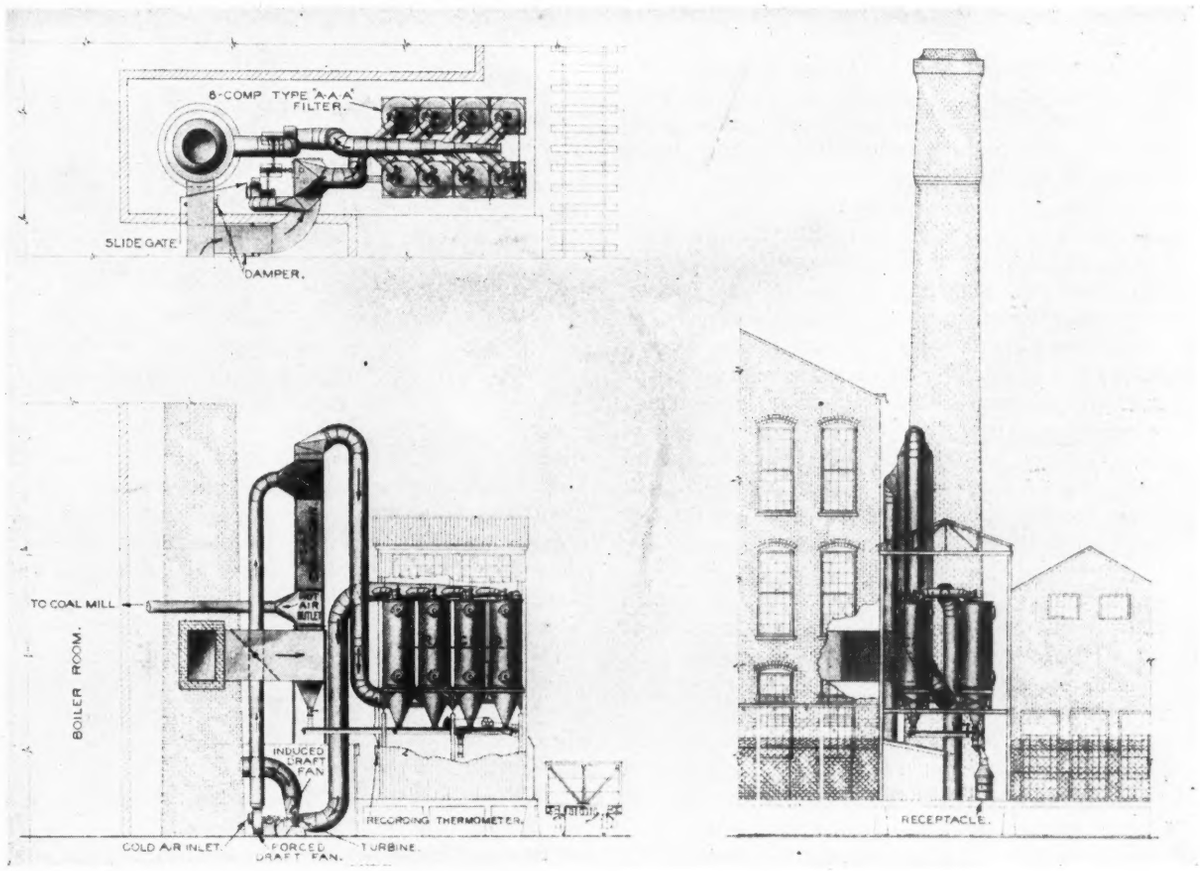
Two old boilers were removed and replaced by a 2,010 sq.ft. Springfield boiler, with 18-ft. tubes set 13 ft. 6 in. above the floor line. This boiler, which operates at 185 lb. pressure, is fired by a unit-type pulverizer operating at 1,750 r.p.m. and driven by either a steam turbine or an electric motor. Two horizontal boilers were retained for emergency service with oil firing and the pulverized-coal burner for the new boiler was installed so that it could be lighted by oil.

The new pulverized-coal-fired boiler proved satisfactory except in one respect, the settlement of fly ash from the stack. This ash was objectionable in that it soiled the textiles in process and in storage in the mill, and was also a source of some complaint from the adjacent residential district.

A thorough study was made of possible methods of recovering this fly ash, which terminated in a decision to install flue gas filters, the type of filter finally chosen being that made by the Dust Recovering & Conveying Company, of Cleveland, Ohio.

The filter equipment proper consists of eight compartments of standard design and construction. The operation of these filters was described in the March 19, 1929, issue of *Power* by H. E. Macomber, of the Detroit Edison Company, where a number of these units are used to filter the coal dust from cyclone vents.

Fig. 1—General arrangement of the complete installation with the paths of the flue gas and cooling air indicated by arrows



In order to cool the flue gas to approximately 240 deg. F., the maximum allowable filter temperature, a plate type of air preheater was installed to act as a heat exchanger. A forced-draft fan supplies cooling air, making possible the use of a considerable portion of the sensible heat of the gas. Part of this heated air will be supplied as primary air to the coal-pulverizing unit. As the load on the power plant is heaviest during

Fig. 2 — Before and after installing filter

the winter months, due to seasonal demand for the manufactured products, a large supply of heated air will then be available for mill heating. At the present time, live steam supplements the exhaust steam used in the heating system, so the reduction of this live-steam demand should effect a saving in fuel. A recording thermometer indicates the temperature of the gas entering the filters, and this temperature is maintained within the specified limits by the manually operated damper on the inlet to the forced-draft fan.

The flue gas is exhausted from the filters through the induced-draft fan, and directed to the stack. Both fans are driven from a steam turbine operated at 175-lb. steam pressure and exhausting into the heating line. The steam to the turbine is controlled by a chronometer valve, connected to a Carrick combustion control system. (The cost of operation of the turbine is low since the exhaust steam replaces live steam in the heating system, most of the year.) The induced-draft fan has a larger capacity than is required to overcome the static pressure of the filter system, so that it can create an increased furnace draft when the load on the plant requires it: one of the reasons for selecting this particular filter system.

The static loss through the entire equipment, which includes the usual draft on the boiler uptake, the loss through the heat exchanger and through the filter, is around $2\frac{1}{2}$ in. of water under the present operating conditions with one boiler.

The ash is precipitated into the hopper under the heat exchanger and into the hoppers that form an integral part of the filter units. The screw-conveyor system carries the ash to a discharge spout, where it is collected in sheet metal containers.

Dampers were placed in the old stack breeching and in the new breeching to the heat exchanger, so that by opening the first and closing the second the unit can be cut out and the flue gas bypassed to the stack. This should not be necessary, however, since the unit construction of the filters makes it possible to cut out one or two compartments temporarily.

The view at the left in Fig. 2 shows the discharge from the stack during the soot-blowing period, before the filter unit was placed in operation. The view at the right is a photograph of the stack taken under the same operating conditions, but after the unit was filtering the flue gas. No discharge is visible. In fact, the only material which can be observed to leave the stack at the present time is occasional steam when soot blowing.

The screen test of the recovered ash, which follows, gives some interesting data:

SCREEN TEST OF AVERAGE SAMPLE OF ASH RECOVERED FROM FILTER UNITS

	Per Cent
Plus 65-mesh screen	0
Plus 100-mesh screen	.25
Plus 150-mesh screen	.76
Plus 200-mesh screen	2.02
Plus 300-mesh screen	3.22
Minus 300-mesh screen	92.7
	98.95

A small percentage of the total ash settles out in the boiler setting, but this does not run higher than 15 per cent. The screen test applies to the remaining 85 per cent, and perhaps the most interesting fact is that over 90 per cent of it passes through a 300-mesh screen. This emphasizes the necessity for high-efficiency collectors for fly-ash recovery, since collectors that are designed to recover solids of a fineness above 200 or 300 mesh would operate on only a small proportion of the ash.

Fig. 3 is a photograph (reduced) of a sample of the recovered ash, magnified one hundred diameters. At this enlargement, one millimeter equals ten microns. It

Fig. 3—Average sample of recovered ash magnified one hundred diameters

is apparent that most of the true ash is smaller than ten microns and makes up the main portion of the sample. The large particles, which are actually of the order of about 50 microns, are really coke and unconsumed carbon. It is, of course, impossible to eliminate a considerable percentage of this combustible in a comparatively small power-plant combustion unit, which must operate part of the time at less than boiler rating.

The recovery of this ash is becoming increasingly important in the design and operation of pulverized-coal-burning power plants. In this particular instance, high-efficiency collection, and the desirability of reclaiming a portion of the sensible heat of the flue-gas were the factors that decided the type of installation. Other factors will doubtless be of greater importance in other plants, but this is at least one solution of a difficult problem.

POWER SERVICES

In a Milk Plant

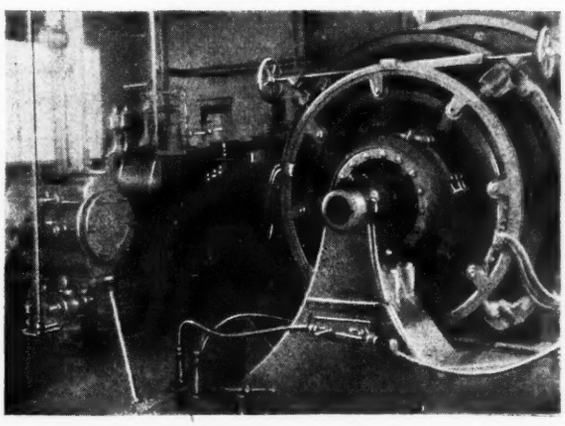
By G. Grow

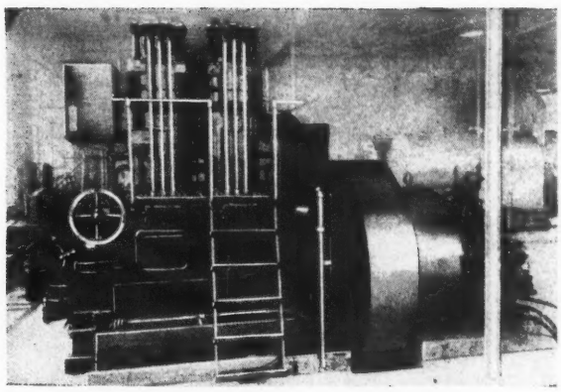
DAIRIES frequently find that the choice of a power source must be either an oil engine or a public utility. In the case of the Walker-Gordon Company's plant at Juliustown, N. J., the Diesel engine has worked out to the better advantage.

Those unfamiliar with the relations of power, refrigeration and hot water in the dairy may assume that the steam engine and boiler should be the logical equipment. However, while power to drive the refrigeration compressor and the deep-well pump is practically constant, the power to operate the various machines in its bottling department is needed only during a part of the day, and the hot-water and steam requirements are only for a few hours daily. In addition, the total power demand is not great, and as the steam plant is more economical in the large capacities, the steam engine is often ruled out of the plan very early in the power study. It is, however, necessary to provide boilers for the steam used in pasteurization and hot water for the bottle and container washing.

Several years ago, when the plant was first put into commission, the load was small, and a 75-kw. Buckeye semi-Diesel engine direct connected to a 250-r.p.m. 225-volt direct-current generator was installed, along with a small boiler.

A semi-Diesel was the first engine installed





The Otto-Superior Diesel used to carry the load

Increased demands necessitated an enlargement of the power supply, and after obtaining a rate from the public utility it seemed desirable to install another oil engine, but of the high-compression, or Diesel, type. At the same time a larger ammonia compressor was installed, a second deep well was sunk and two boilers were installed.

At present, power is generated by a 120-hp. Otto-Superior two-cylinder, 13¼-in. bore by 17-in. stroke, solid-injection Diesel, direct connected to a 75-kw. Crocker-Wheeler 275-r.p.m. 250-volt generator. Jacket-cooling water flows by gravity from an overhead storage tank. To supply air for starting, the engine has a 4.5x5 in. Worthington compressor belted to a 7-hp. Alamo gasoline engine.

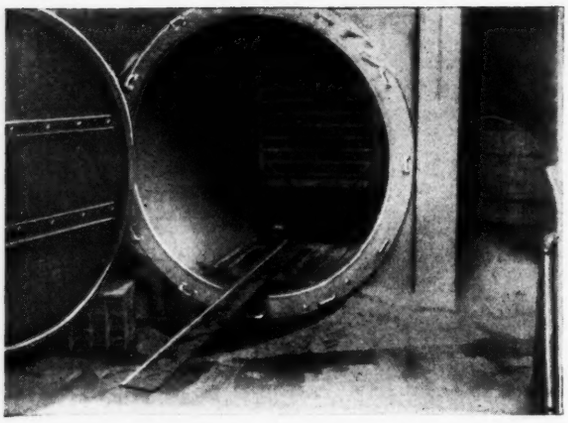
Fuel oil costs six cents a gallon delivered, and an average of 10 kw.-hr. a gallon is obtained over a period of several months. Lubricating oil costs are extremely low, as the engine delivers approximately 3,000 kw.-hr. per gallon of oil.

To supply the refrigeration, a 50-hp. 560-r.p.m. General Electric motor belt-drives a York 8x8-in. duplex-cylinder 16-ton compressor. The ammonia condenser is made up of two stands of six double-pipe coils placed alongside the ice-making tank in a room adjoining the engine room. Approximately 8,500 lb. of ice is produced each day for use in packing the bottle crates.

Brine cooled in the ice tank is also circulated to the milk-cooling coils by two 2-in. Goulds centrifugal pumps direct connected to 1,750-r.p.m. Western Electric motors. The milk passes through the coils of the brine cooler and is reduced in temperature to 40 deg., at which temperature it is bottled and put in storage for delivery.

To supply water for various purposes about the dairy a deep well was put in just outside the engine room. While the bore is 900 ft. deep, the water level is about 80 ft. below the ground level. The air-lift system is used; an 8x8-in. Ingersoll-Rand compressor supplies air at 125 lb., being driven by a 10-hp. 900-r.p.m. motor. The water discharges into a sump, out of which it is forced into a 50,000-gal. overhead tank by motor-driven pumps. As a standby unit there is a 6x6-in. Curtis two-cylinder compressor, belt driven by a 10-hp. 1,250-r.p.m. motor.

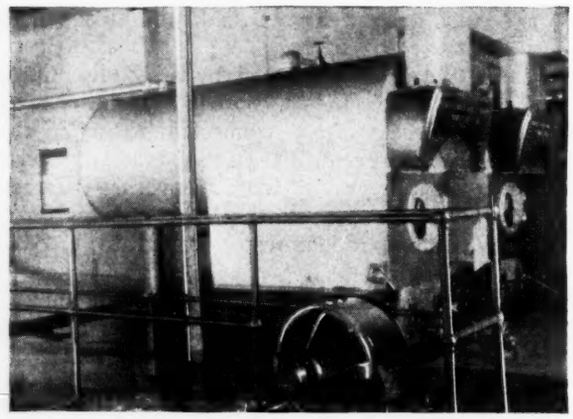
To supply the steam and hot water the dairy installed two 500-sq.ft. Coatesville locomotive-type boilers. Steam is supplied at 15-lb. pressure to the pasteurizers. These consist of large steel pressure tanks, with hinged-door



The pasteurizing tanks charged with bottles

ends, into which the bottles are placed. Steam is admitted, and the bottles are held at 225 deg. F. for about 30 minutes.

Hot water is taken from below the boiler-water line. Because of the low steam pressure it is possible to feed



Two locomotive boilers supply low-pressure steam

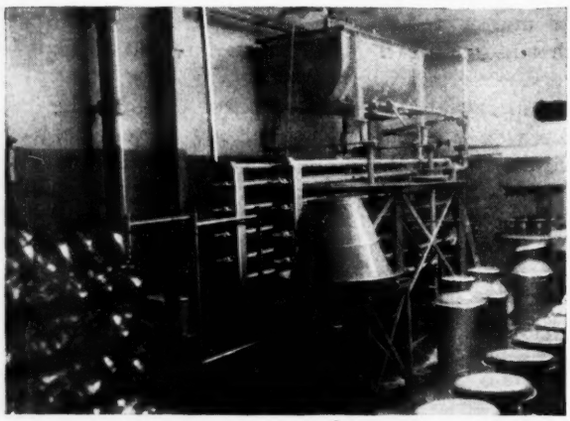
the boiler by gravity from the overhead storage tank.

In such small power plants, the labor item may become too high if an engineer and fireman are employed. Consequently, oil is used as the boiler fuel, which enables the engineer to attend both boilers and engine.

Two sets of fuel-pumping units, manufactured by the Burner Corporation, were installed. Each consists of a 1-in. rotary pump and a blower direct connected to a 1½-hp. motor.

An interesting innovation is the York air conditioner installed in the milking rooms. Through the use of direct-expansion ammonia coils, air passing through the conditioner is cooled to about 60 deg. in summer, and in winter the air is raised to the same temperature by steam coils.

While most of the power is used to drive the ammonia compressor, the air lift, and to carry the lighting load, power is also supplied to the motors scattered about the building. These consist of a 5-hp. motor in the laundry, a 2.5-hp. on the bottling machine, a 15-hp. on the feed mixer, a 50-hp. on the ensilage cutter and two 16-hp. motors on the air conditioners in the milking shed.



The warm milk is cooled by brine before bottling

Corrosion Fatigue Studied by Navy Engineers

AN INVESTIGATION of corrosion fatigue now being carried on by the engineering experiment station of the United States Navy Department makes clear just how serious the combined action of corrosion and continued stress becomes. When the two phenomena are combined, they are mutually accelerated. As a result of corrosion fatigue, metals may fail at stresses which are only a small fraction of the stresses that they will endure if corrosion is absent. For example, a spring steel that will endure alternating stresses of 108,000 lb. per sq.in. in air without failure will fail at a stress of 12,000 lb. per sq.in. in water.

Corrosion fatigue affects non-ferrous as well as ferrous metals. Investigation at the experiment station has shown also, that the corrosion-fatigue limit for machinery parts of large size is no greater than for small parts, such as a bar only one-half inch in diameter. This accounts for many mysterious failures of large shafting. Recent investigation of failure of propeller shafting of submarines have shown their failures to be due to corrosion fatigue. Corrosion fatigue of these shafts occurred between the propeller hub and sleeve. Under such conditions—that is, with the shaft working in sea water—alternating torsional stresses of only 5,000 or 6,000 lb. per sq.in. would probably be sufficient to cause failure in time. The failure of a submarine stern diving shaft has been attributed to the same cause.

The effect of stress-cycle frequency is being investigated. Results to date indicate that a frequency of 1 cycle per hour or even less may considerably accelerate corrosion pitting. This is being done to investigate the possible action in large machinery, something of the nature of a boiler, where the cycle can be considered as the changes that occur from the time the boiler is lighted off, brought up to pressure, and finally cooled off to its original cold status. In connection with the investigations of corrosion fatigue of metals it has been found that a good preventive coating, such as cadmium, or even red lead, materially enhances the life of both ferrous and non-ferrous metals. Investigations are now under way to determine the effect of various platings and other coatings to prevent corrosion fatigue. The discovery of a method by which this phenomenon might be eliminated would be a notable advance in the science of metallurgy, both from the standpoint of safety and the standpoint of economy.

Power-Record Man Responsible for Instruments and Records

And Should Co-operate with the Operating Force

By Walter N. Polakov*
Consulting Engineer, New York City

Nothing is more important to the proper management of a power plant than the correct use of instruments and the records that they supply. The instructions presented herewith give concisely the procedure to be followed in organizing this service.

THE RECORDS of power-plant performance and cost of operation, if accurately kept, are indispensable means of control and serve as guides for continuous improvement by means of removing obstacles or weak spots disclosed by them. The absence of such data would leave an executive in the dark, so far as direction of his effort is concerned, while inaccuracies in such matters may be dangerously misleading.

Frequently such data as are available from instruments neglectfully kept are worked out by the chief operating engineer to the prejudice of his direct duties, whereas cost data are either unavailable or handled by the clerks in the cost department. These men are not familiar with the problems in the power plant and cannot interpret the circumstances. Data without intelligent interpretation are meaningless.

Record-keeping should be centralized and responsibility allocated to one man, provided the plant is large enough to warrant it. The duties of power-record man are suggested in the following instruction. In very large power houses these and similar duties are performed by a planning department. In smaller plants these duties are discharged by a power-plant clerk. In some cases these duties are divided between the power-plant clerk and the steam and power dispatcher.

Duties of Power-Record Man

The power-record man relieves the chief operating engineer or plant superintendent from detail duties for which he is responsible. The scope of these details, delegated to the power-record man, is briefly defined as *custody of recording equipment and record data* pertaining to generation, distribution and ultilization of steam and power.

Authority: The chief operating engineer delegates to him such authority as necessary and sufficient for successful discharge of his duties.

Responsiblity: The power-record man is responsible to the chief operating engineer for:

1. Maintenance of instruments and meters.
2. Correct indication and recording of the same.
3. Accurate and immediate collection of all available records.
4. Proper filing of all reference data.
5. Correct distribution of time (men and machinery).
6. Balance of stores in the power sub-store.
7. Accurate and prompt distribution of expenses (operating and maintenance).

Special Duties: From time to time the power-record man is assigned special tasks, time permitting, to collect special data, gather specific information or take special readings, run special tests and the like.

Reports on these special observations should be made *at once* with original readings attached and submitted to the chief operating engineer before the assignmem is reported as completed.

Location: The power-record man is provided with a tool chest or cabinet and work bench in the power house for care and testing of instruments. He uses desk and filing and calculating facilities in the chief operating engineer's office.

Co-operation: The power-record man in the course of the discharge of his duties co-operates with all members of the operating force, adjusting their instruments, giving explanations, keeping records, etc.; and all employs are expected to co-operate with him by calling to his attention all errors or irregularities, etc.

He also co-operates and is entitled to co-operation from the mechanical department, pipe-fitters, electricians, etc., whose services he requisitions through the chief operating engineer. In special cases, he is entitled to call for outside expert assistance, such as the services of manufacturers of instruments. Such requests, however, should be made through the chief operating engineer.

Bonus: For every day when all recording instruments necessary for a complete record of operating performance are in good operating condition, he receives a bonus of 5 per cent of his daily wage. The bonus is forfeited if any of the instruments (indicating or recording) needed for control or record of operating conditions on units in service are out of order or readings are impossible.

Exception: If any instrument goes bad three days after his report of "repairs needed," his bonus is allowed.

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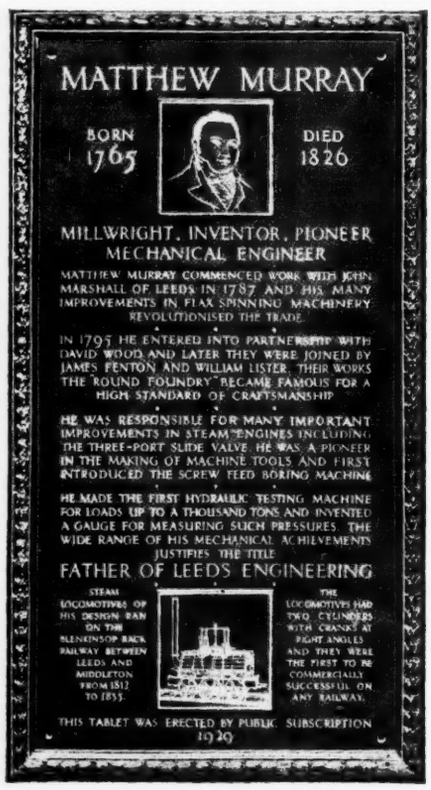
Matthew Murray

Pioneer

POWER ENGINEER

1765—1826

THE recent unveiling of a bronze tablet on the site of the old "Round Foundry" in Leeds, England, to the memory of Matthew Murray, "The Father of Leeds Engineering," largely through the efforts of E. Kilburn Scott, well-known British electrical engineer, actively supplemented by officers of the Institution of Mechanical Engineers and the Newcomen Society, brings out some interesting and forgotten data on early power engineering. This is the third of a series of memorials by which the Matthew Murray Memorial Fund, of which Mr. Scott is chairman, is seeking to establish recognition of the genius of Murray, who, far more than James Watt, started the engineering trade of Leeds and helped spread it throughout the world.


MATTHEW MURRAY
BORN 1765
DIED 1826
MILLWRIGHT, INVENTOR, PIONEER MECHANICAL ENGINEER
MATTHEW MURRAY COMMENCED WORK WITH JOHN MARSHALL OF LEEDS IN 1787 AND HIS MANY IMPROVEMENTS IN FLAX SPINNING MACHINERY REVOLUTIONISED THE TRADE.
IN 1795 HE ENTERED INTO PARTNERSHIP WITH DAVID WOOD AND LATER THEY WERE JOINED BY JAMES FENTON AND WILLIAM LISTER. THEIR WORKS THE ROUND FOUNDRY BECAME FAMOUS FOR A HIGH STANDARD OF CRAFTSMANSHIP
HE WAS RESPONSIBLE FOR MANY IMPORTANT IMPROVEMENTS IN STEAM ENGINES INCLUDING THE THREE-PORT SLIDE VALVE. HE WAS A PIONEER IN THE MAKING OF MACHINE TOOLS AND FIRST INTRODUCED THE SCREW FEED BORING MACHINE
HE MADE THE FIRST HYDRAULIC TESTING MACHINE FOR LOADS UP TO A THOUSAND TONS AND INVENTED A GAUGE FOR MEASURING SUCH PRESSURES. THE WIDE RANGE OF HIS MECHANICAL ACHIEVEMENTS JUSTIFIES THE TITLE
FATHER OF LEEDS ENGINEERING
STEAM LOCOMOTIVES OF HIS DESIGN RAN ON THE BLENKINSOP RACK RAILWAY BETWEEN LEEDS AND MIDDLETON FROM 1812 TO 1835.
THE LOCOMOTIVES HAD TWO CYLINDERS WITH CRANKS AT RIGHT ANGLES AND THEY WERE THE FIRST TO BE COMMERCIALLY SUCCESSFUL ON ANY RAILWAY.
THIS TABLET WAS ERECTED BY PUBLIC SUBSCRIPTION 1929

Murray was born in 1765 in Newcastle-on-Tyne. Little is known of his early life beyond the fact that he seems to have made the very best use of his opportunities at school. His father apprenticed him to a millwright or mechanic, it is thought, in his native town, where he married before the completion of his term of service. He then went to Stockton-on-Tees, finished his apprenticeship and worked as a journeyman in a mechanic's shop. Trade becoming bad there, he decided to try his fortune in Leeds, where great efforts were being made to introduce machinery in several of the manufactories. At Adel, five miles from Leeds, he found that John Marshall, a flax manufacturer, needed assistance. Marshall was among the first to use machinery in flax manufacturing, and soon he made Murray his chief mechanic and paid him in addition £20 for several suggestions and improvements on his machinery and power plant.

In 1790 Murray took out his first patent for a machine for spinning flax, cotton or silk. In 1793 a steam engine superseded the water-wheel at Marshall's factory, and Murray had charge of this and introduced several minor improvements. In this same year he took out a patent which included a carding engine and spinning machine. He introduced "sponge" weights and the process of wet spinning of flax, which created a revolution in the trade. But for his improvements at that time it is nearly certain that flax-spinning in this neighborhood would have ceased to exist, so much capital had been lost by the old methods.

At the end of twelve years Murray left Marshall to join a firm later known as Fenton, Murray & Wood, and devote his entire energies to making improvements in the steam engine. He suggested making engines simpler in construction by placing the cylinder in a horizontal position and making connection with the flywheel shaft by a rack and pinion arrangement, almost identical with a motion afterward used in printing machinery. He also invented a method of regulating the draft in the chimney according to the pressure in the boiler, this being effected by a small steam cylinder, the piston rod of which, by means of a rack and pinion, opened and closed the damper. All these inventions were included in his patent No. 2,327, of 1799.

In 1801 Murray took out a patent described as "New Methods and Improvements of Constructing the Air Pump and Sundry Other Parts," this also including drop valves, valve gear, cylinder packing, parallel motion and a method of constructing boiler fireplaces that consumed their smoke and had a cog wheel and rack for mechanically pushing the coal forward, virtually a mechanical stoker.

The demand for Murray's engines soon made it necessary for the firm to erect a larger factory. This was done under his direction in 1802 and among the new buildings was an assembly shop built in the shape of an engine cylinder, the famous old "Round Foundry." Near the works Murray built himself a house, which was the first to be centrally heated by steam. It is still standing and occupied, and is known locally as Holbeck Lodge or more familiarly as "Steam Lodge."

At about this time James Watt, Jr., of the firm of Boulton & Watt, came to Leeds for the purpose of spying upon Murray's firm because it had become an active competitor of Boulton & Watt. Two years earlier William Murdock, the manager of their Soho works, had been hospitably entertained at Steam Hall by Murray, who showed him round his works and gave Murdock a sample of his own smithwork. He took particulars of Murray's cylinder-boring mills, which were novel in having automatic screw feed and boring very accurate sur-

faces. There exist an astonishing series of letters exchanged between James Watt, Jr., and Boulton at this time which show the extent of their jealousy of Murray's achievements and business. They copied his methods, maintaining spys within his works for that purpose; protested his patents for the slightest minor resemblances; and even bought up land adjacent to his firm's property to prevent it from spreading out. But when Murray wished to visit the Soho works of Boulton & Watt, he was politely but firmly refused admission to the premises.

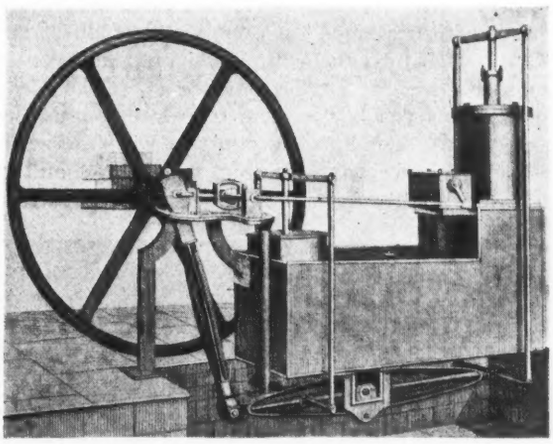
It is said that one reason Murray made such excellent engines was that he used machine tools extensively. His reputation in this special branch of manufacture grew and he exported tools to France, Sweden and Russia. This was the beginning of the machine tool business, which afterward spread and made the engineering industry the accurate business it is today. Murray was undoubtedly the first to make a large hydraulic testing, or "proving" machine, and in these days when so much is heard about the importance of scientific research and of testing materials, it is interesting to know that he was engaged in such work over a century ago.

It has been usual to give Fulton credit for commercializing steam-propelled vessels, but Matthew Murray is also worthy of praise because of his pioneer work. In 1813 a French privateeer called "L'Actif" was brought under sail to the Canal Basin, Leeds, and an engine and boiler fitted into her by Murray's firm. The engine had a cylinder 8 in. in diameter and a 2-ft. 6-in. stroke. It delivered eight horsepower when supplied with what was then called "high pressure" steam—probably about 30 lb. per sq.in. Renamed the "Experiment" the boat was "steamed" to Yarmouth and when put into regular work often ran at a speed of from ten to twelve miles an hour. It proved a great success. This was an early application of steam to regular passenger traffic. The engine and boiler of the "Experiment" were later transferred to the "Courier," which plied in the open sea—the first steam boat to make a voyage to sea. About this time Francis Ogden, United States Consul to Liverpool, became interested in Murray's engines, and he engaged his firm to build several engines for steam boats, one of which was put on a steam tug on the Mississippi River. This was a double-beam engine according to Murray's design, with cranks set at right angles and driving the paddle shaft by spur gearing. It is said to have frequently hauled upstream a ship from 300 to 400 tons on each side, and two smaller vessels, brigs or schooners, towed astern. It is interesting to note that James Watt did not approve of propelling vessels by steam engines and in 1800 had written to Henry Bell that it was "pure waste of time."

From the point of view of the general public, the most striking part of Murray's work during these fruitful years, was the development of the steam locomotive. His first locomotive, built on the order of John Blenkinsop, to ply on the railroad which he had patented and planned to lay between his colliery in Middleton and Leeds, differed from any that preceded it by having two cylinders working on two cranks set at right angles in order to obtain a steady tractive effort and thus be able to start hauling the full load, regardless of what position the locomotive might be in. Although this locomotive weighed only five tons, it could haul 90 tons. There are pictures and accounts in the *Leeds Mercury* and other scientific papers of the day describing the first trip of the "The Old Engine" running across Hunslet Moor pushing and pulling wagons of coal on the Iron Railway.

Murray did his constructive work in an age of cast-iron, although even then, in a letter to Simon Goodrich, engineer and mechanist to the navy board, in regard to a navy order for a testing machine, he writes, "After it is made I intend to try a set of experiments with it, upon cast and wrought iron to determine and compare the strength in certain positions." In another letter to Goodrich, in 1824, Murray discusses the difficulty, due to excessive weight, of using a reciprocating engine in a "horse-less" carriage, and he mentions the desirability of a rotary or circular steam engine. He also describes an "explosive gas engine" which, he says, is not original, having been unsuccessfully tried 40 years before. These references are of particular interest at the present time, when steam turbines and internal-combustion engines find such wide application.

Murray was a typical example of the old patriarchal type of employer, who called his men by their Christian



Murray's Inverted Beam Engine of 1805

names, and long after he died it was an asset for any mechanic or millwright to say that he had worked with "T'old Mattha Mirror" as he was called. The obelisk which marks his grave was made by his workmen of cast iron. By the helpfulness in importing information, he was a father to those who worked with him. His success was partly due to the able co-operation of men he gathered round him, for he had the faculty of a born leader in being able to choose clever assistants. A great many of the most famous engineers of that time were schooled under him, including Samuel Owen.

After Murray's death, in 1826, the firm ran until 1843, when a number of workmen pooled their interests and carried it on for several years—an early and seemingly successful experiment in industrial co-partnership. The Round Foundry was burned down in 1872 and, unfortunately along with it the carefully preserved drawings, correspondence and patterns of the Murray régime. The bronze memorial tablet shown in the accompanying reproduction was affixed to the wall of the Crabtree works, which now stand on the same site.

In the preparation of this article, use has been made of Mr. Scott's interesting book, "Matthew Murray," published in 1928. Readers who wish to pursue the subject further may obtain copies of the book by sending three shillings to the Matthew Murray Memorial Fund, 84 Kingsway, W. C.2, London, England.

THE LICENSE COMMITTEE of the National Association of Power Engineers reports that there are 850 steam plants in the state of Rhode Island employing 4,000 boilers for power purposes.

Right Out of the Plant

The Smoke Detective and How It Takes Testimony

OCCASIONALLY, in a neighborhood infested with smoke, there may be seen a young chap carrying a large wooden box. Presently the box is deposited on the ground, presumably aimed at one or more smokestacks, and left there for the better part of the day.

The box contains a smoke-recording camera recently developed by the faculty of Stevens Institute of Technology, of Hoboken, N. J. The box when the top is removed, discloses a conventional clockwork motion-picture camera, arranged for exposing a single "frame," or picture, each time the button is depressed. And this function, in turn, is handled by means of an electromagnetic plunger, which is actuated at regular intervals by a clockwork switch. A group of "B" batteries furnish the necessary electric power, with relays and condencers and resistors as required for smooth operation.

Smoke-recording camera and its operator

In use the smoke-recording camera automatically snaps a picture every ten seconds to a minute, depending on the requirements of the operator. A long-focus lens is used, so that the camera may be placed at a considerable distance from the smokestack. When the film is finished and developed, it may be projected on a screen at the usual speed of sixteen pictures per second, in which case the smoke of an entire day may be reviewed.

Croton-on-Hudson, N. Y. A. C. LESCARBOURA.

Spring Wedges for Leveling Machinery

IN THE article by G. F. McClay in the May 7 number on "Spring Wadges for Leveling Machinery," I notice the statement that the usual method of leveling is by "driving the wedges in at the low points." This was news to me. To check up further, I asked other erecting men, and each of them said that he never drove in the wedges.

The method each of us was accustomed to use was to raise the engine bed with a pinch bar or other means and push the wedge into place. For heavy machine beds jacks can be used, both for leveling and lining up.

The objection to driving wedges with a hammer is the same as the one given by Mr. McClay, that in driving the wedges the machine may be moved out of line by the force of the blows from the hammer.

Los Angeles, Calif. HOWARD LIVINGSTON.

Effect of CO_2 on Power Plant Economy

IN THE Jan. 8 number C. B. Sprague, in his article, "Effect of CO_2 on Power Plant Economy," deals with an important subject that brings out the interdependence of the heat-loss factors and their effect on economic power production.

Mr. Sprague bases his determinations on the percentage of CO_2, the fundamental and most available heat-loss index. He shows graphically how the economic effect of CO_2 is modified by the economizer and steam superheater. Curve *A*, Fig. 1, illustrates how the heat loss varies with the percentage of CO_2, in percentage of heat input. Curve *B* shows how the heat loss in percentage of heat output, is influenced by variation of flue-gas temperature resulting from changes in CO_2. Curve *C* shows how the heat loss decreases through the economizer. Curve *D* takes into account the economic effect of the reduction of superheat caused by the decrease in weight of gas passing over the superheater due to the increase in the percentage of CO_2.

Each succeeding stage in the process of steam generation depends on one preceding for the heat per pound of fuel available to it. The more potential heat (combustible) of the coal that is wasted over or through the grate, the less the furnace can deliver to the boiler. On the other hand, the more of the heat delivered by the furnace the boiler absorbs, the less is supplied to the economizer; hence it will return less heat to the boiler with the feed water. The economizer receiving less heat will also deliver less heat to the air preheater, and proportionately less heat can be recuperated and returned to the furnace. The quantitative effect of this inter-relation of the five stages, which comprise boiler operation in a completely equipped boiler plant, will vary with the rate of driving and the percentage of excess air of which CO_2 is the index.

Table I gives the summations of the heat-loss decrements each one per cent of CO_2 increase from 10 to 14 per cent, *a*, *b*, *c*, *d* are graphically illustrated in Fig. 2 by the curves, which serve to show more clearly how the economic effect of CO_2 is modified by the operating conditions represented by the data and results given in

Table I. Curve *E* represents the rate of heat loss decrease on the assumption that 50 per cent of the heat in the gas on leaving the economizer was recuperated by the air preheater. These curves show clearly that the more nearly all the heat contained in the gas on leaving the boiler is recovered by economizers and air preheaters,

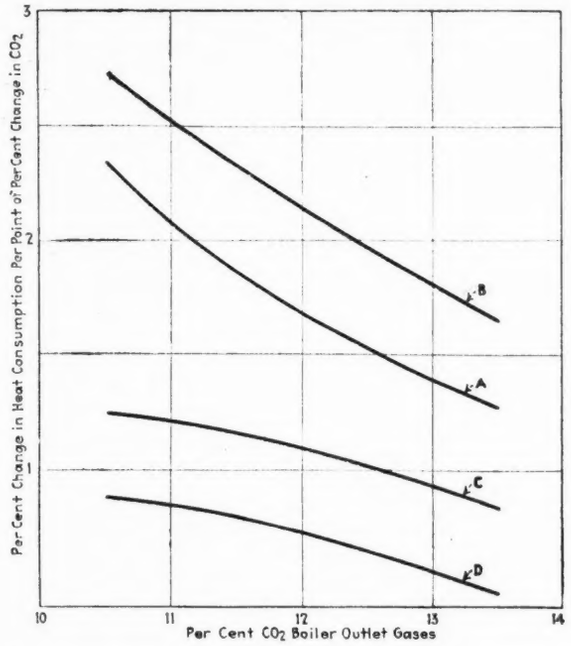


Fig. 1—Reproduction of the curves in Mr. Sprague's article

the less can be gained by increasing the percentage of CO_2.

In brick-lined furnaces the CO_2 is limited by the heat resistance of the furnace arches and lining, because the furnace temperature rises as the CO_2 increases, as is shown by Table II, which gives the theoretical temperatures of combustion. The actual furnace temperature is always much lower. How much lower depends on the area of heating surface facing the furnace and the manner of introducing the air required to complete combustion of the gas rising from the fire bed. In water-cooled furnaces the maintenance cost due to high CO_2 is reduced

TABLE I—SUMMATION OF HEAT LOSS DECREMENTS

CO_2 increase		1	2	3	4
10 to 11 per cent	*a*	2.74	2.00	1.25	0.88
11 to 12 per cent		2.32	1.70	1.16	0.79
10 to 12 per cent	*b*	5.06	3.70	2.41	1.67
12 to 13 per cent		1.98	1.45	1.02	0.62
10 to 13 per cent	*c*	7.04	5.15	3.43	2.29
13 to 14 per cent		1.64	1.20	0.84	0.44
10 to 14 per cent	*d*	8.68	6.35	4.27	2.73

Column 1—Reduction of heat in dry gas from the boiler, due to increase in CO_2 based on heat output.

Column 2—Reduction of heat in dry gas from boiler based on heat input.

Column 3—Reduction in heat in dry gas from economizer based on heat output.

Column 4—Takes into account the economic effect due to the reduction of superheat in steam with increased CO_2.

TABLE II—THEORETICAL FURNACE TEMPERATURES

Per cent CO_2	9	10	11	12	13	14	15
Temperature	2,513	2,760	3,010	3,251	3,468	3,717	3,606

to the minimum, if not to a negligible quantity.

The percentage of CO_2 is also limited by the increasing loss of combustible in the gas and in the refuse. In large and properly constructed furnaces the former loss is practically negligible. In such furnaces the heat loss increments due to CO per each one per cent CO_2 increase will not equal the heat loss decrements below 16 per cent CO_2.

In boilers with insufficient furnace capacity these heat-loss increments in the gas may in some cases approach the heat loss decrements below 14 per cent CO_2. As yet a large number of boilers are hand fired, in which the loss of combustible in the refuse is not affected by high CO_2, and since these boilers are generally not equipped with economizers or superheaters, the percentage of CO_2 is limited only by the increase in cost of furnace upkeep.

In determining the reduction of the economic effect of high CO_2 in the boiler because of the reduction of the heat available to the economizer and air preheater, the losses due to air infiltration and radiation should also be determined. In comparison with the difficulty in determining loss of combustible in the refuse, this would seem to be comparatively easy.

Increasing the percentage of CO_2 will decrease the temperatures all along the line from boiler to stack, hence there will be an appreciable decrease in the radiation losses. It will decrease the weight of air required for combustion, and this will decrease the draft, the two combining to reduce the power required to propel the air and gas through the boiler system. Decreased draft will decrease air infiltration and the losses it entails. And, last, but not least, increasing the percentage of CO_2 increases the steaming capacity of the boiler proportionately to the reduction in the weight of gas produced per pound of fuel burned.

Thus in determining the most economical percentage of CO_2 all gains must be added as well as all losses

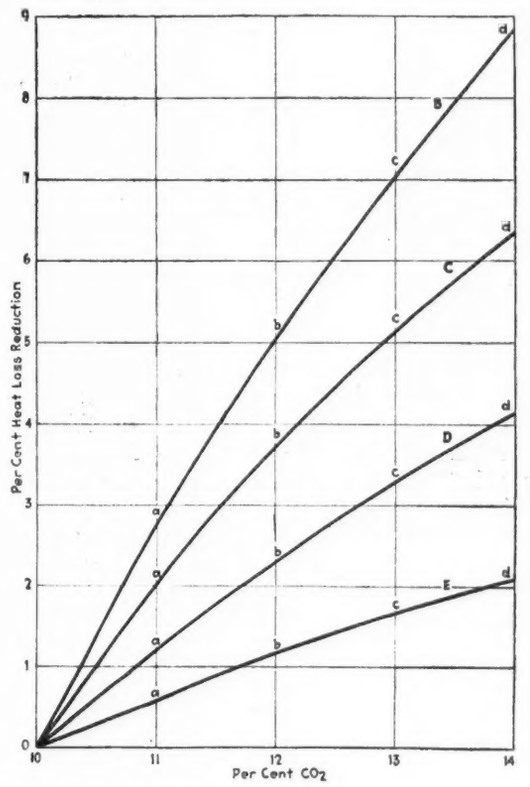


Fig. 2—Shows graphically the data given in Table I

deducted. What is needed most, however, is an exposition of the state of the art, and Mr. Sprague has made a creditable start. No doubt, many power-plant engineers have more or less complete data pertaining to the subject, which, if published, would prove valuable to their fellow engineers.

E. A. Uehling, M.E., *Dr. of Engineering.*
Milwaukee, Wis.

On the Cause of Burnt-Out Bearings

A BURNT-OUT bearing on an important piece of machinery or prime mover in an industrial plant is naturally a cause of great annoyance, especially where a temporary stoppage means loss of time and reduced production. At such times the engineer, in seeking a cause for the failure, almost invariably thinks first of the lubricating oil, and his natural reaction is to make an immediate change. Hasty conclusions of this kind without thorough investigation of all possible contributory causes are unwise and frequently incorrect, as illustrated by the following specific experience.

About eighteen months ago three 250-kw. steam engines direct connected to electric generators were installed in a plant in an Eastern city. They were operated through the summer months when engine room temperatures ranged from 120 to 125 deg. and bearing temperatures from 145 to 155 deg. The lubricating oil was a good quality bearing oil of 230 seconds Saybolt viscosity at 100 deg. F.

After a year's successful operation bearing trouble began to develop, and within a week three bearings had been burned out—two on one engine and one on another. An interesting feature of the situation was that the failure in each case occurred in the outboard bearing, and not in the main bearings, which are subjected to greater load. Also, since the main bearings are oiled from a circulating lubrication system, there is more likelihood of water contamination than in the case of the outboard bearings, which are lubricated from a separate oil reservoir. It was immediately concluded that the oil was the cause of this sudden failure, in spite of twelve months' uninterrupted service, and a heavier-bodied oil of higher flash and fire point was put into the system.

In a short time the new oil began to show similar signs of fatigue. This became evident to the operating engineer when he noted a rapid darkening in color, which resulted in the oil becoming almost black. It might be mentioned that oxidation of hydrocarbon oils is invariably accompanied by a darkening in color and a development of free fatty acid. This is a progressive chemical reaction in which hydrocarbons are oxidized through intermediate stages until some of them are converted into their corresponding acids. The rate of this reaction, while extremely slow at ordinary temperatures, is greatly increased at high temperatures.

A close watch was kept on oil performance by observing hourly readings of the temperatures as recorded by a thermometer submerged in the oil reservoir. At 7 o'clock one morning the engineer found the oil temperature to be 139 deg. At 7:45 a.m. the temperature had jumped to 168 deg., and the oil was off color. He switched another engine into the line, and by the time the load was transferred the oil temperature had risen to 178 deg. The outboard bearing failed fifteen minutes after the engineer had first noticed the rapid discoloration of the oil. On dismantling and examining the bearing, it was found that the bottom portion had become scorched and widened, indicating that the metal had run.

The engine manufacturer at once took a sample of the oil and had it tested. He reported back that it was entirely suitable for the lubrication of these engines. The oil company reciprocated by having an analysis made of a sample of the bearing metal, and this indeed proved to be "the nigger in the woodpile."

It is a well-known fact that bearing metal that is too soft causes heated bearings, as it yields to the pressure and slowly flows, so that the bearing surface constantly changes and never assumes a good working skin. One of the essentials of a good bearing metal is that it should maintain a low running temperature; that is, it should have a high thermal conductivity. In this respect white metals containing a high percentage of lead are inferior to those rich in tin and containing little or no lead.

In the particular instance referred to, the bearing metal proved to have too high a lead content. The bearings have been relined with a better quality white metal and are once again running successfully and at normal temperatures.

E. R. WOODWARD.

Long Island City, N. Y.

Early Experiences With Pumps and Diesel Engines

ON INSTALLING a six-cylinder Diesel engine unit in one plant, the erecting man recommended a centrifugal pump, but the engine manufacturer differed with him, and a triplex power pump was purchased.

The lift varied from 6 to 15 ft., due to fluctuations in the level of the water in the forebay, so it is probable that a centrifugal pump would have given considerable trouble.

When the time came to start the engine it was felt that the pump should be started first, so the cooling water would be available as soon as the engine was turning over. The water had to go somewhere before the engine valves were opened, and it was some problem to get a relief valve to handle the capacity of the pump and then close completely when the pressure went low enough.

Most of the spring-loaded water-relief valves were to prevent damage to the pump castings, and if they were adjusted so that the pressure would not exceed 15 lb., when the pressure dropped to 5 lb. the spring had so little range that the water continued to flow from the valve. It is probably that a valve with long spring travel could have been designed to operate satisfactorily, but a suitable valve could not be readily obtained.

It was therefore suggested that an old weight-and-lever steam safety valve be used, and, with the addition of a stuffing box around the stem, this worked fine. When the pump was started the pressure rose to about 15 lb., and as soon as the valves were opened on the pipes to the cylinder jackets it dropped to about 7 lb. and remained there. The weight has this advantage: It will keep on dropping until the valve is closed if the pressure goes low enough, which is something that the average spring will not always do.

The size of the pump was 4x5 in. and it delivered about 110 gallons a minute. A good, if not better, arrangement was suggested at the time. This was to erect a 4-in. standpipe, with the overflow about twelve feet above the highest point of the engine. This would avoid any undue pressures on the pump or piping and yet water would be available at any time, and if the valves were closed the water would run out through the overflow.

In another plant, where there were two engines like the first, a pump of the same size was installed and run slightly faster. At that time the cylinder castings of the engines were so heavy that the builders recommended plenty of cooling water, and it was customary to have it discharge at a comparatively low temperature.

Where the water can run to the pump, the centrifugal type seems to be the best.

Cambridge, Mass. G. H. KIMBALL.

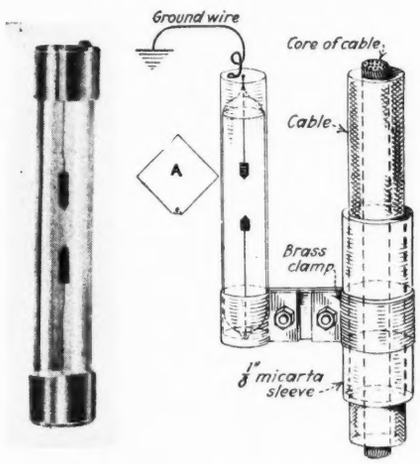
What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

High-Voltage Indicator Uses Neon Tube

A HIGH-VOLTAGE indicator consisting of a permanently mounted visible light to show when a conductor is dead or alive has recently been introduced by the Martindale Electric Company, 1260 West 4th St., Cleveland, Ohio.

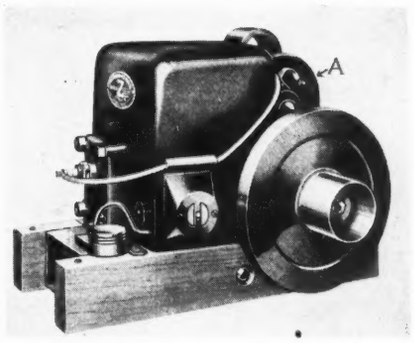
The indicator is a sensitive neon discharge tube equipped with special electrodes and assembled in a glass



Indicator tube and method of connecting it to the conductor

housing capped with brass ferrules. When installed on a line conductor the tube glows at comparatively low voltages. The accompanying illustration shows the indicator tube and the method of connecting it to a conductor.

In voltages between 2,000 and 4,000 a ground connection is used and the tube is set in the looped end of a metal strap, which is in turn wrapped around additional micarta insulation placed on the conductor. When used on conductors carrying a voltage above 4,000 no ground connection is used and no additional insulation is used between the clamp and the conductor. If the cable is lead sheathed the sheath is removed where the clamp is attached. When no ground connection is used the plate shown at *A* can be attached to the free end of the tube to increase the light. The device measures $4\frac{5}{8}$ in. long by $\frac{7}{16}$ in. in diameter.



Portable engine with two-speed drives

Small Enclosed Engine for Portable Services

A NEW line of small gasoline-kerosene engines, recently announced by Fairbanks, Morse & Company, Chicago, Ill., departs considerably from the conventional design. The engine is completely enclosed, and grease cups are eliminated by a self-oiling system, which keeps all moving parts flushed with oil. Features to abolish leaking oil and crankcase compression also are incorporated in the design.

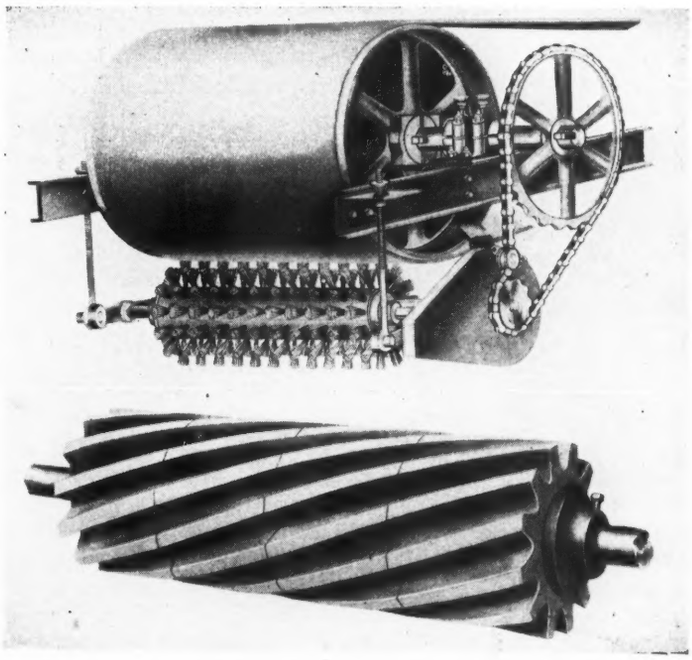
The illustration shows the $1\frac{1}{2}$-hp. engine. This model is less than 16 in. high, 22 in. long and 19 in. wide. It weighs 150 lb. Two pulleys are on opposite sides of the engine, one operating at engine speed of 1,500 r.p.m., and the other operating at 750 r.p.m.

Unit construction throughout makes the cylinder, water hopper, crankcase and bearing supports for both crankshaft and camshaft integral parts of the cylinder and base casting. The engines are particularly suitable for driving portable pumps, air compressors, small generators and similar types of equipment.

Fluted Rubber Cleaning Brush for Belt Conveyors

THE upper half of the illustration shows the general arrangement of a belt-conveyor head pulley equipped with a Bassene cleaning brush, and the lower half the new "Squeegee" cleaning brush brought out by the Robins Conveying Belt Company, 15 Park Row, New York City.

The new brush, which has been



Conveyor head pulley with brush-driving mechanism and new "Squeegee" brush

designed to give better cleaning results with less wear on the belt than the former types, consists of a series of spiral flutes made of high-grade rubber. The roll is $7\frac{1}{2}$ in. outside diameter and made up in sections six inches long. The sections are mounted on a wooden core the same diameter as used on the older type brushes, so that the brushes now in use can readily be replaced with the new brush without any change in the driving mechanism.

The rubber cleaner turns with a peripheral speed of about 1,000 ft. per minute and the wearing part is about $\frac{3}{4}$ in. deep. The spiral shape of the flutes tend to keep the belt from flopping up and down.

One of the principal advantages of the rubber cleaner brush is that it need only bear lightly against the belt, and this reduces materially the wear on the belt as well as on the cleaner.

Single-Retort Side-Dump Underfeed Stoker

A SIDE-DUMP, single-retort stoker has recently been developed by the Dayton Stoker Company, Dayton, Ohio. This stoker, which is of the central-retort type, is made in two grate lengths and four grate widths, giving six different grate areas, with coal-burning capacities up to 2,200 pounds per hour.

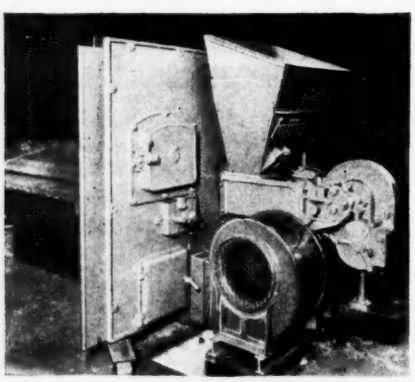


Fig. 1—Front view of stoker

The front end of the retort is bolted to the stoker front, and the rear end is carried on a cross frame, which supports it rigidly but allows for longitudinal expansion. The space under the stoker is divided into three compartments. The central compartment is supplied with air under pressure from the forced-draft fan, while the other two compartments serve as ash pits. The top plates of the dump section are replacable without disturbing the supporting arm and guard assembly. A two-to-one gearing on the dumps eases the manual operation.

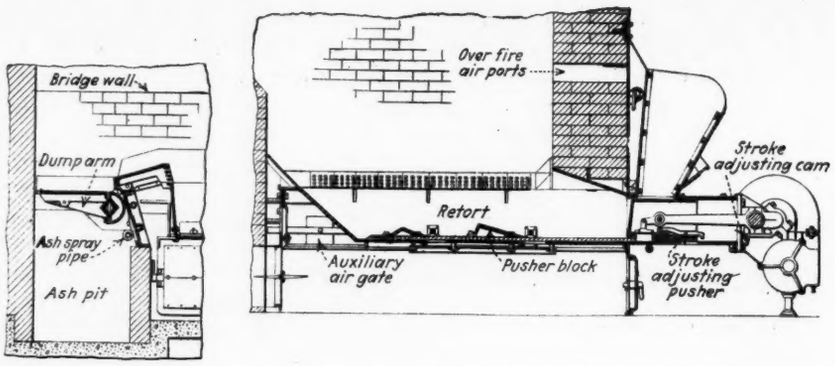


Fig. 2—Partial cross-sction and sectional elevation of stoker

A cast-iron coal hopper of about 300 lb. capacity is furnished as standard equipment. A reciprocating ram and a pusher plate supported on rollers operate in the bottom of the retort to distribute the fuel, and the rate is varied by changing the stroke of the plate in relation to that of the ram. The gear-box is equipped with roller bearings and uses heat-treated alloy-steel gears operating in an oil bath. A safety clutch prevents damage to the feeding mechanism. Air is taken from the main air compartment and supplied over the top of the fire to take care of the heavy initial distillation of volatile matter. This overfire air is slightly preheated by being passed through ports in the front wall.

Unit-type stokers are driven by a motor which is built into the stoker, but a chain drive is available where the stoker is installed with remotely located forced-draft equipment.

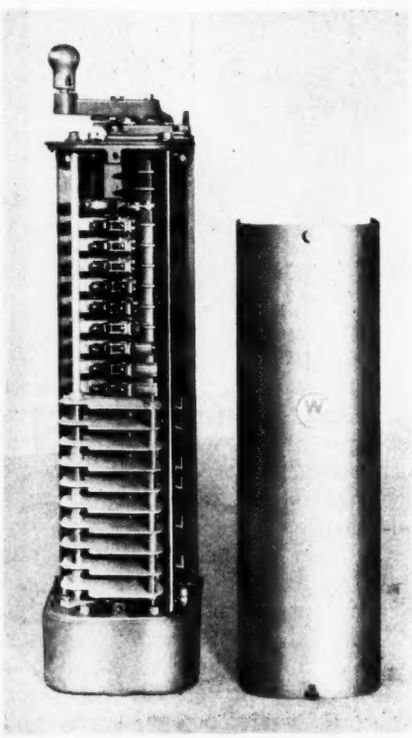
Insulating and Protecting Lacquer for Metal Surfaces

A NEW lacquer, said to be unusually resistant to acids, alkalies, mineral oils and high temperatures has been developed in the research laboratories of the General Electric Company. It is marketed under the trade name "Glyptal," by the merchandise department, at Bridgeport, Conn. It is said to be particularly suitable for sealing joints in gas mains, for painting structural iron, motors, oil tanks and other metal parts requiring insulating paints of high dielectric strength.

The lacquer is available in five colors. It may be applied by brushing, spraying or dipping. It dries dust free in about 30 minutes, and to a hard finish in about ten hours.

Improved Reversing Drum Controllers

STEEL parts have replaced castings wherever practicable in the new reversing drum controllers put out by the Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa. These controllers, which will be known at Type A, are designed for operating cranes, bending rolls, and for other heavy duty work. They are made for both alternating and direct current service.



Controller with cover removed

The drum cylinder consists of rolled brass supporting disks assembled on a micarta-insulated steel shaft between brass and micarta collars. The contact segments are bolted to the disks in such a way as to eliminate burning of the bolt heads.

The fingers are self-aligning, and

adjustment may be made to compensate for finger wear. Copper shunts from the terminals to the finger tips prevent localized heating at the joint. A ball thrust bearing in the base and a flexible roller bearing in the top allows easy operation of the controller. The apparatus is available with several types of operating heads.

Improved Oil Switches and Circuit Breakers

A LINE of oil switches and circuit breakers embodying several novel developments is now being manufactured by the Roller-Smith Company, 233 Broadway, New York City. Known as Type "O," these breakers range in capacity from

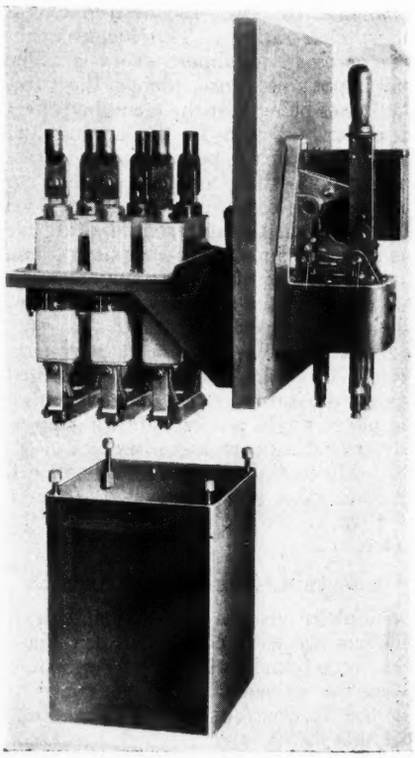


Fig. 1—Breaker mounted with operating mechanism

200 to 2,000 amperes, from 2,500 to 15,000 volts, and with interrupting capacities from 20,000 to 40,000 kva. They are made in two-pole and three-pole models, automatic and non-automatic, single and double throw, with various types of mountings. Remote control, electrical or hand operation, and special designs to meet exceptional requirements can be supplied.

As shown in Fig. 2, laminated copper leads extend from the terminals through the porcelain insulators and are clamped at the bottom to form inverted brushes. The construction of the brush at the lower end of each lead is such that a long wiping action is secured. Each lamination picks up separately, leaving an oil-circulating space between laminations. The arcing tips are so designed that electromagnetic stress increases the contact pressure and holds them in engagement for a considerable time after the brushes disengage on the opening stroke.

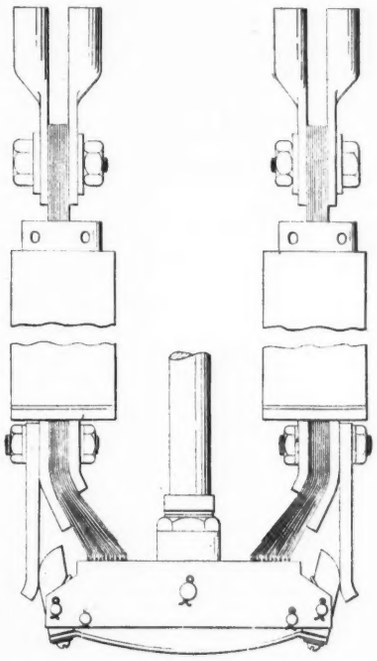


Fig. 2—Laminated copper leads extend from terminals to bridging members

The moving bridging member is relatively light, thus giving high opening speed. It is self-aligning, and adjustable on the contact rod to secure proper contact.

The elimination of oil throw by the use of an internal operating mechanism, by abolishing the holes in the breaker top and by providing a double flange around the tank seat is an important advance. The closing mechanism is internally mounted on centers drilled in the breaker frame. A toggle with a long lever arm effects easy closure. Alignment of the cross bar which carries the three contact rods is obtained by two sets of metal guides.

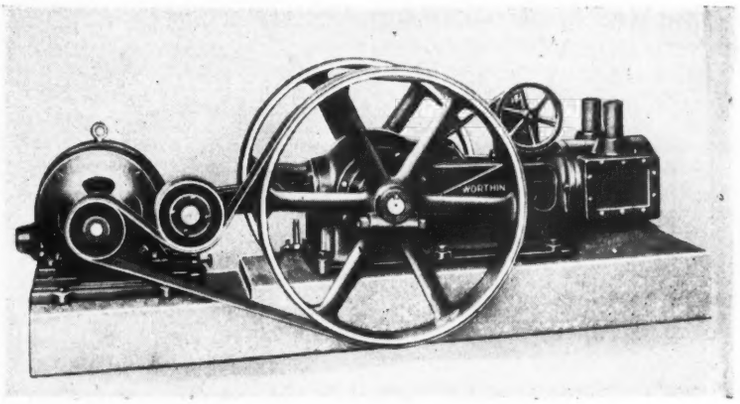
The tank is of welded steel, and is lined with a high insulating material. Partitions between phases are also provided. Relatively large volumes for oil and gas expansion are allowed

Roller-Bearing Equipped Compressors

A NEW line of compressors, employing roller bearings on the main crankshaft journals, has been announced by the Worthington Pump and Machinery Corporation, Harrison, N. J. The line includes the single horizontal straight-line series, in capacities ranging from 100 to 300 cu.ft. per minute. The adoption of Timken roller bearings tends to reduce the attention required, and the elimination of bearing adjustments has removed the principal item of maintenance.

Oil rings, which deflect the surplus oil and return it to the crankcase, are mounted on the shaft beyond the roller bearings. The crankcase enclosure is completely oil tight. "Feather valves" are standard equipment. Regulation may be by an automatic starter and pressure switch mounted on the motor, stopping and starting it to control the air pressure between definite limits. Or a pressure regulator may be attached to the compressor inlet valves, holding them open to maintain constant air pressure.

These compressors can be furnished with ball-bearing idlers for short belt drive; with Texrope drives, using V-type ropes; or a synchronous motor may be directly mounted on the compressor crankshaft, as best suits the installation requirements.



Compressor with roller bearings on the crankshaft

Simplifying the Setting of Boiler Meters

By W. G. Lauffer

Testing Engineer, Brooklyn Edison Company

The setting of the air-flow mechanism of a boiler meter sometimes proves to be a tedious job. In this article a method is outlined which permits setting the air-flow meter by deadweights and one Orsat analysis. It is an abstract of a paper on "The Properties and Characteristics of the Air-Flow Mechanism of a Boiler Meter" presented at a meeting of the Metropolitan Section of the A.S.M.E.

THE largest controllable loss in a modern steam generating station is the stack loss. In the design of a station it is usually assumed that control of the stack loss will be satisfactorily effected by the installation and use of combustion guides. The air-flow mechanism of a well-known boiler meter is used at the Hudson Avenue station for control and indication of the stack loss. The proper operation and calibration of this meter had not apparently been properly understood nor completely developed. However, the detailed study of the properties and characteristics of the mechanism has resulted in an indicator of combustion efficiency that is reliable within close limits.

Elements of the Boiler Meter

The flow elements of the boiler meter in question measure the flow of steam from the boiler and the flow of products of combustion through the boiler. The air-flow pen is to be so adjusted that when the fuel is being burned with the proper amount of air, the two pens, indicating air and steam flow, show the same reading on the meter chart.

The steam meter consists of a bell actuated by the difference in pressure just before and immediately after an orifice or flow nozzle in the steam line from the superheater outlet to the header. This bell is so shaped that the movement is proportional to the square root of the actuating differential, and consequently directly proportional to the flow causing the differential.

The air-flow meter measures the flow or flue gas through the boiler and is actuated by the differential draft between two points in the gas path. The difference in draft between these two points represents a loss of head due to the gas flow through the boiler, and is proportional to the square of the flow. Since, however, in this meter the steam and air pens are to be coincident, the air-flow meter must, like the steam meter, give a deflection that is proportional to the flow. This is accomplished by counterweighing the arm from which the draft-actuated bells hang, with a weight, which is immersed in mercury. This weight, or displacer, is so shaped that in withdrawing it from the mercury the force exerted by it on the arm will cause the meter reading to be proportional to the flow of combustion products.

Analysis of the flue gases by Orsat is the basis on which the meter adjustments were checked and considerable difficulty had been experienced in obtaining reliable and consistent checks. When the radius was set according to the results of Orsat analysis at one rating, it was usually found that it was impossible to check the desired excess air at other ratings. This inconsistency was ascribed to almost every possible and impossible cause, among the principal ones being that the changing effect of chimney action in the second and third passes of the boiler made accurate setting impossible, and that differences in fuel-bed condition caused decided differences in the differential draft for the same air supplied. It has been found that neither of these has any discernible effect on the accuracy of the meter, when it is properly adjusted.

As a possible solution it was suggested that the meter be calibrated against draft directly, on the chance that the meter might not be indicating properly the rating corresponding to a given draft differential. This was accomplished by connecting a liquid-level draft gage in parallel with the air bells of the meter.

Deadweight Method of Checking

Simultaneous gas analyses and draft differentials with coincident pen readings were found to be rather confusing. There was so much uncertainty concerning the accuracy of the draft readings that this method was discarded in favor of the "deadweight check."

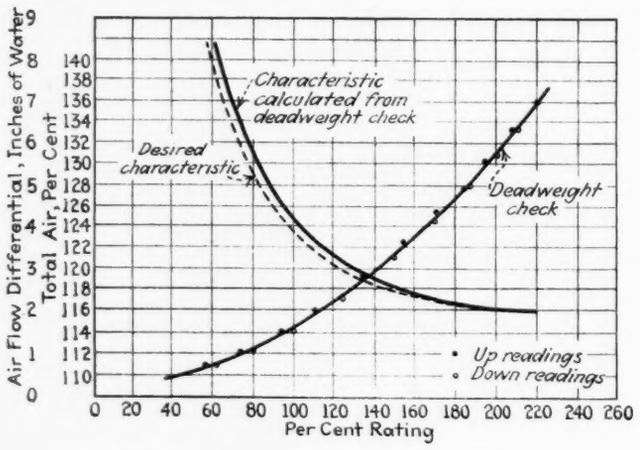


Fig. 1—Deadweight check of the air-flow mechanism and the total air characteristics calculated from it

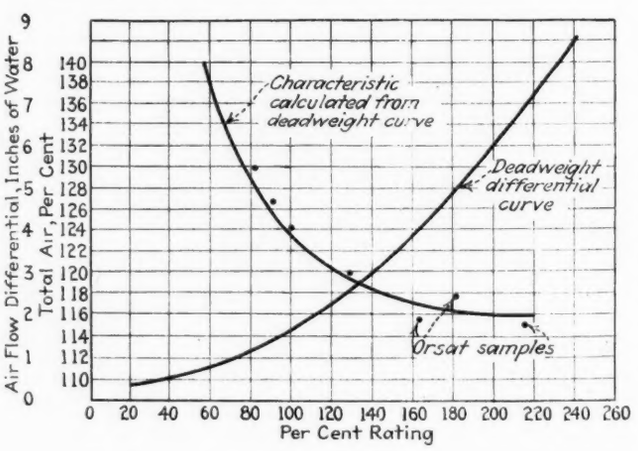


Fig. 2—Comparison of total air characteristics by deadweight check with that obtained by flue-gas analysis

The "deadweight check" applies a method of computation by means of which the shape of the total air characteristic can be calculated for a series of rating points, if the differential drafts at these ratings are known. This method assumes, first: that the resistance of the boiler as a conduit is constant for a given condition of cleanliness, and that, therefore, the friction loss through it is exactly proportional to the square of the flow; and, second, that the actual evaporation per pound of coal is constant at all boiler loads within the limits imposed by the accuracy of the measurements.[1]

If, then, the drafts, at any two ratings are known, the respective rates of air flow are proportional to the square roots of the drafts. Also, if the coal burned is proportional to the rating, the quantity of air theoretically required for combustion is proportional to the rating, and the air flow then is proportional to the product of rating and per cent total air. (Per cent total air is the ratio of the quantity of air actually supplied to the boiler to that theoretically required for combustion, expressed in per cent; or, in other words, it is 100 per cent plus the per cent excess air.) We therefore have two expressions—square root of draft, and product of rating and per cent total air—both proportional to the same quantity, air flow. If we know the change in one, the change in the other may be determined. Thus, for example, suppose that an Orsat analysis has shown that at 200 per cent of rating the total air is 116 per cent, and the differential draft at this point is 0.69 in. If the draft at 90 per cent of rating is 0.154 the total air at 90 per cent of rating may be found as follows:

Let F_1 = air flow at 200 per cent
and F_2 = air flow at 90 per cent

$$F_1 = 200 \times 1.16 = 232$$

$$\text{Now } \frac{F_2}{F_1} = \frac{\sqrt{0.154}}{\sqrt{0.690}}$$

$$\text{So } \frac{F_2}{232} = \frac{\sqrt{0.154}}{\sqrt{0.690}}$$

$$F_2 = \frac{\sqrt{0.154}}{\sqrt{0.690}} \times 232 = 110$$

And $F_2 = 90 \times$ per cent total air $= 110$

$$\text{Per cent total air} = \frac{110}{90} = 122 \text{ per cent}$$

at 90 per cent of rating.

Calibration of the meters by means of the method just outlined was then undertaken. This was accomplished by disconnecting the meter from the boiler, applying an artificial differential which is measured by a draft gage in parallel with the meter, and calculating the total air characteristic from this "deadweight check." These readings may be plotted and the total air characteristic derived. If the characteristic is found to be incorrect, the trouble can be quickly diagnosed and the necessary steps taken to correct it.

[1]Discussion disclosed that because of the increase in feed-water temperature with plant load, the evaporation per pound of coal remains nearly constant for this plant.

A typical "deadweight check" is shown in Fig. 1, and from it is calculated the characteristic curve shown by the solid line in the same illustration. The dashed curve represents the characteristic desired.

These curves show the characteristic to be a little too steep; that is, it is too high at the low ratings. The remedy is to balance the meter slightly lighter at zero. If the value of total air as indicated by the deadweight were found to be too low at the low ratings—that is, less than 120 per cent air at 120 per cent rating—it would be necessary to weight the meter heavier at zero. It has been found possible to obtain a wide range of characteristics of total air with respect to rating, from a slightly rising one to a steeply falling one, simply by changing the balance and keeping the displacer and the mercury level in the displacer pot the same.

It is clear from this example, since the value of total air at 200 per cent of rating is assumed, that the deadweight check determines only the shape of the characteristic curve of the meter; that is, it determines, for any radius setting of the displacer, the relative values of total air at different ratings. However, to get the correct values of total air over the entire range of ratings it is only necessary to set the meter to the correct value of total air as determined by Orsat analysis at one rating. The values of total air at other ratings will then be correct as determined by the deadweight check. It is, of course, obvious that an assumed total air value may be used, a satisfactory characteristic obtained by the deadweight method, and the Orsat analysis made last. If the Orsat analysis checks the assumed value within reasonable limits (1 to 2 per cent total air) the characteristic may be regarded to be satisfactory as originally determined.

This procedure is unquestionably simpler, shorter and more accurate than obtaining the number of Orsat checks necessary to cover the whole range, with the attendant probabilities of error.

After making a number of deadweight checks and calculating the corresponding total air curves, it became evident that the curve of differential against boiler rating was always of the form expressed by the equation, $y = ax^n + c$, where y = differential, x = rating and a and c = determinable constants.

Since the curve of differential vs. rating is constant in form, it follows that there is only one combination of proper displacer shape and weighing to give the desired effect.

Determining Desired Total Air Characteristic

The characteristic is a curve showing the excess or total air in per cent as a function of rating when the stoker is being operated with the air and steam pens together. This function determines,

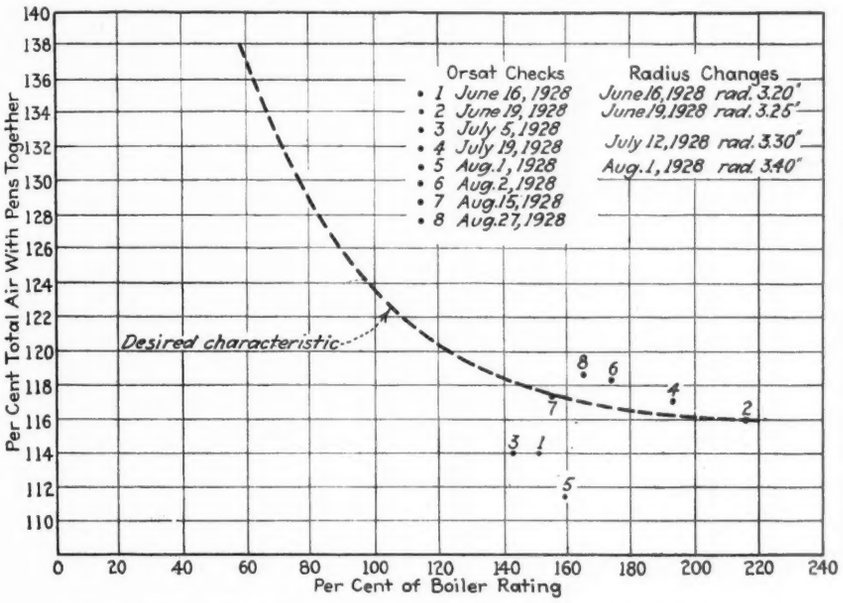

Per Cent Total Air With Pens Together
Per Cent of Boiler Rating
Orsat Checks
1 June 16, 1928
2 June 19, 1928
3 July 5, 1928
4 July 19, 1928
5 Aug. 1, 1928
6 Aug. 2, 1928
7 Aug. 15, 1928
8 Aug. 27, 1928
Radius Changes
June 16, 1928 rad. 3.20"
June 19, 1928 rad. 3.25"
July 12, 1928 rad. 3.30"
Aug. 1, 1928 rad. 3.40"
Desired characteristic

Fig. 3—Record of Orsat checks, showing changes made to compensate for fouling of boiler

once the boiler and stoker are in service, the performance of the boiler; since the total air determines the stack loss directly, the refuse loss indirectly, and also the magnitude of the maintenance charges on the stoker and on furnace brickwork. Thus, it is clear that assigning values of total air at which the stoker is to be operated is largely a matter of engineering judgment rather than a problem that may be solved by precise mathematical reasoning. The principal factors to be considered are:

1. The excess air should be kept as low as possible without creating a loss due to incomplete combustion, represented by carbon monoxide in the flue gases or excessive combustible in the refuse.

2. The furnace temperature should be controlled by regulation of excess air so that the walls will not be unduly eroded by the high-temperature gases or slag.

It has been found that it is possible

to operate the 285 lb. pressure boilers at Hudson Avenue at as low as 110 per cent total air without a trace of CO in the flue gases at high ratings, but the furnace temperatures then run so high that the walls slag badly. If the total air is increased to 116 per cent at 200 per cent of rating, excessive slagging of the walls stops. As the rating is decreased the total air may be kept approximately constant over an appreciable rating range, but by the time the rating has decreased to 120 per cent, the air necessary for combustion without a trace of CO has increased to 120 per cent, and at 100 per cent of rating about 123 per cent total air is necessary. Thus the characteristic that is desired for the 285 lb. pressure boilers is that shown in Fig. 1. The meters of the 400 lb. pressure boilers have been adjusted for approximately constant excess air throughout the operating rating range.

Deadweight Method Checked by Orsat

It then became necessary to prove that the work that had been done was justified, by demonstrating that it would pass the test, "Does it work?" Everything had been based on the assumption that the differential was a true indication of the rate of air flow. The only possible check was by flue-gas analysis. The results of a series of analyses run on a boiler that had been properly set by the deadweight check, must agree over the entire range with the characteristic predicted by the deadweight.

A series of Orsat checks was run on each boiler in the 285 lb. pressure station to determine whether these check points would coincide with the predicted curves. A typical one made before the desired total air curve had been agreed on, is shown as Fig. 2.

The agreement between the total air characteristics as determined by the deadweights and checked by Orsat analysis, as illustrated in Fig. 2 is within the attainable precision of measurement. The assumptions made in using the deadweight method and in deriving the displacer contour are thus proven valid.

As the boilers remain in service, accumulation of soot and slag on the tubes increases the draft differential between the meter connections for a given rate of gas flow. Consequently, for the same differential, the rate of gas flow will be decreased. The per cent total air with air and steam pens coincident will therefore be decreased. To counteract this action, it is necessary to lengthen the radius at which the displacer acts.

At intervals of ten days to two weeks, a flue-gas analysis by Orsat is run on each boiler in service. The checks are made when the boiler is being operated so that the air and steam pens are approximately together. Five sets of samples are taken while conditions are constant, at any rating. From the Orsat analysis the per cent total air is computed and corrected for any slight difference in the readings of the air and steam pens, to the condition of pens exactly together.

This gives the total air for which the meter is set when the pens are together at the rating indicated by the air pen. The average of these data is then plotted on a sheet having on it the curve of desired total air vs. rating as in Fig. 3, which shows the record of a boiler for a three months' period. It shows each Orsat check that is made on that boiler, its date, and the radius at which the meter was set when the check was run.

If an Orsat check shows a departure from the standard greater than about 2 per cent total air, the radius is changed by a quantity computed from the factor of 5 per cent excess air per tenth-inch change in radius. The new radius value and the date of making the change are noted on the boiler sheet, Fig. 3.

The use of this system has had some valuable byproducts. It has shown that the radius of the meter need not be changed so often, nor by such large increments as was formerly thought to be necessary. The maximum increase over the normal period of three months between boiler cleanings of the radius is about 0.20 in. This corresponds to an increase in draft differential of about 20 per cent, or from about 0.60 in. of water to 0.72 in. of water at 200 per cent of rating. This is a reasonable increase, since the meter draft taps are at the top of the first and third passes, between which points there can be only a relatively light accumulation of soot as the boiler gets dirty. Most of the increases in boiler draft loss must occur in the first pass of the boiler, and this does not affect the meter.

Knowing the normal draft drop at 200 per cent of rating for a clean boiler, it has been found possible to reset the meter radius and establish the desired total air characteristic while a boiler is out for external cleaning. Only the formality of an Orsat check is then necessary after the boiler comes on the line, to verify the estimated degree of external cleanliness. The exit flue-gas temperature and the efficiency of the boiler are used as independent measures of the cleanliness of the boiler.

Furthermore, the indicated radius changes furnish a good check on the condition of the baffling. It is apparent that if the radius change indicated by an Orsat check is not so great as it should be when considering the time the boiler has been in service, it may very probably be that the baffling is in bad condition.

Steam Turbine Lubrication Demands High Quality Oil

THE distinctive features of steam turbine operation which affect lubrication requirements are summarized in Engineering Bulletin No. T-39, issued by the research laboratories of the Standard Oil Company of Indiana. "Turbine lubrication," says the bulletin, "imposes unusual strains on the lubricant, as bearing temperatures are rather high in spite of the rapid circulation of oil as a cooling medium; also this rapid circulation facilitates air mixing with the oil, with consequent oxidation and further deterioration."

The characteristics of various turbine oils may be considered from two standpoints. From the standpoint of lubricating qualities, the following requirements are necessary: Effective separation of friction surfaces by a layer of oil; high adhesiveness to friction surfaces at low speeds; low internal friction of oil; and maximum cooling effect, which requires high fluidity and high specific heat. All of these lubricating qualities are determined by the oil viscosity.

The requirements for lasting qualities, however, are of the greatest interest to those concerned with the economics of turbine operation. In turbine oils, flashpoints are always so far above operating temperatures that the small differences between various brands of oil are without real significance. Turbine oils must, on the other hand, be extremely free from injurious substances, such as dirt, dust, acids or emulsifying materials. Contaminants found in turbine oils are classified in the following groups:

1. Dust, finely divided rust, core-sand, etc., are abrasives that will be found to a certain extent under the best conditions. These impurities not only cause wear of bearings, but increase the rate of emulsion formation between oil and water.

2. Water accumulating in the oil from leaks in the oil cooler or sealing water from the packing glands may cause serious emulsion difficulties when the oil is in poor condition.

3. Acids formed in the oil by oxidation will slowly attack the iron surfaces and form iron soaps. Both the fatty acids and the resultant soaps are strong emulsifying materials, so that high acidity means poor water separation.

4. Sludges and deposits, largely iron soaps and asphalt-like gummy oxidation products of the oil, settle out in the cooler. These act as a cement for any other solid impurities.

The usual tests for turbine oils—acidity, steam emulsion, etc.—give an indication of the condition of the oil at the time of testing, but they show little or nothing regarding its stability.

The real worth of a turbine oil is best determined by a service test, or by a laboratory test designed to simulate service conditions, the article claims. The Standard Oil Research Laboratory developed the "Rogers Stability Test" for this purpose. The results obtained compare satisfactorily with longer runs in turbines.

The test consists of agitating a quantity of the oil with oxygen at 212 deg. F. for 500 hours. Small samples are periodically withdrawn and tested for acidity and emulsibility. One hour in the laboratory has been found to equal many hours of service.

Saving Dollars in the Hotel Power Plant

The author suggests operating the engineering department as a business deriving its income from selling power and heat to the hotel

WHEN speaking before the New York State Hotel Association, at Buffalo, N. Y., Julius G. Berger, consulting engineer of Newark, N. J. called attention to how to save dollars that go up the stack, into the ash pile and down the sewer from hotel power plants. He said, in part:

Has it ever occurred to you, who direct the activity of hotels that many an unseen dollar is lost in smoke that leaves the stack, in the waste going to sewer and in the ash pile? You may say you know such losses exist and you have a chief in the boiler room or power plant who looks after the saving of such things.

No doubt this is true, but you have a bookkeeper and still you have auditors to guide your bookkeeping department in a manner that makes it most efficient; you consult dietitians rather than depend entirely upon your chef; you call in interior decorators, not depending exclusively on your painter, paper hanger or rug or furniture departments. Still, your chief engineer is often left without such assistance or interest on the part of the management that this department deserves.

Heat, light and power, while not really treated with indifference by those in charge of the destiny of hotels, nevertheless are looked upon as more or less necessary evils. It is true that the boiler room of the past, and many of the present day, is not an inviting place for the management to spend much time.

Engineering Department Run as a Business

Another reason for the little attention the engineering department gets is that this department under the method of accounting does not show an income but is regarded as an expense. Naturally, there is a disinclination to spend more money on this end of the business than is absolutely necessary. Things would take on a different aspect if the so-called engineering department were operated as a business with an income which it derived by selling heat, light and power to the other departments. The management would then watch the balance sheet more carefully and would soon know whether new investments were warranted and whether operations were profitable. The present method is unfair, in that other departments have to bear the cost of one that is wastefully operated, without the management knowing the real facts. On the other hand, the chief engineer would take a different point of view in the operation of his department if he knew that a profit commensurate with the investment represented by the equipment under his supervision had to be shown at the end of the year or his services would not be appreciated.

It is not surprising, then, to learn that the efficiency of many hotel power plants is low. However, there are two angles from which the power plant of a hotel has to be considered. First, and the more important one, is the assurance of continuity of service; secondly, economy. The first is more readily realized by the management, and a good percentage of hotels have more than amply provided for an uninterrupted service. It is the economical operation of the plant that is being ignored.

Cost of Heat and Power

Statistics indicate that the cost for heat, light and power in a modern hotel is about one-tenth of the total running expense and is somewhere in the neighborhood of $100 per room per year. Allowing 10 per cent for maintenance, fuel is by far the most important item of the remaining 90 per cent and therefore offers the biggest possibility of substantial savings.

The stack loss in percentage of the heat in the coal is found to be 29 per cent for the average plant and 10 per cent for the well operated plant. Most of this difference can easily be saved by providing the boilers with necessary instruments and equipment that will enable the engineer to maintain the boilers in good condition and operate them properly. Once a policy of economical operation is established, it should apply over all the power plant as well. If the coal bill were $10,000 per year and the loss in heat in the stack gases were 29 per cent instead of 10 per cent then 19 per cent, or approximately $1,900 worth of coal, could be saved by better operation of the same equipment. This might mean repairs costing little or it might require a change in methods requiring the cooperation of the men in the power department.

Hot-Water Losses

Improper methods of supplying hot water, incorrect temperatures of the house hot water supply and waste of condensed steam are all factors that lead to an excess of water at high temperature going into the sewer.

Other sources of waste are radiation losses due to poor insulation or no insulation of piping. The fact that the piping is in a hot boiler room has caused many to believe that the expense of insulation is not warranted. It is well to remember that no matter how hot the boiler room air is, it is many degrees cooler than even the lowest-pressure steam in the pipes. How much return may be expected from the investment of proper insulation can easily be figured, knowing that one square foot of bare pipe as represented by a one-foot length of 3-in. pipe will cause a loss of more than one-quarter of a ton of coal per year. The cost of insulating one square foot is approximately 50 cents, and based on coal at $6 per ton the saving is $1.50 per year, or 300 per cent return on the insulation investment. This also eliminates hot boiler-room ceilings, which often are a costly nuisance.

In applying the principles of economy, possible savings in labor should not be overlooked, and whether the installation of labor-saving equipment is warranted is a matter of careful engineering investigation. If this is done in advance, the management will save itself much disappointment and regret.

Good Operation Necessary

Good equipment alone will not insure efficient performance, but must be supplemented by good operation. It is necessary to organize the operating force, charging each one with specific duties and work out operating schedules, so that the human element will be eliminated as much as possible. Also, provide periodic inspection of equipment and instruments. Furthermore, records must be kept to allow judging the performance of both equipment and operating force.

Much trouble and anxiety would be avoided and expense saved if more consideration were given to the power plant. In many hotels, as well as other lines of business requiring power numerous essential features seem to have been overlooked. As a result, we find impractical fuel storage, difficult ash disposal, poorly arranged equipment resulting in unnecessary piping, no consideration of accessibility of equipment for renewals and repair, incorrect motors used—resulting in poor-power factor—and often insufficient boiler capacity and an inadequate chimney. Noise, vibration and poor ventilation often complete this sad picture. No wonder, then, that it is frequently heard from those who have purchased a hotel built by others that, were they to build one, they would erect the power plant first and then build the hotel around it.

MECHANICAL STRESSES *seen as* Chief Cause of CRACKS in Boiler Plate

AT THE recent convention of the National Board of Boiler and Pressure Vessel Inspectors, J. C. McCabe, of Detroit, presented the accompanying discussion dealing with the cause of cracks at boiler joints, following a paper by F. G. Straub on "Embrittlement in Steam Boilers." Mr. McCabe thought that the word embrittlement was a misnomer, as in tests he had made, the metal under surface cracks in the plate supposedly due to embrittlement was ductile and had not hardened, as might have been anticipated. Mechanical reasons, in his opinion, were the prime cause of cracked plates, although he did admit that caustic soda would contribute to and hasten the cracking of already overloaded metal. Design and workmanship were responsible for loading riveted joints to the yield point. Add to this the residual stresses, the stress due to internal pressure in service and the internal stresses due to the temperature differential through the joint, the presence of caustic, which elevates the temperature of transmission and has a corrosive tendency, may well precipitate a failure already at a balance. Reasons for these conclusions originated from the results obtained in a number of tests that had been made, which he summarized in his discussion as given in the following paragraphs:

The modern concept of good and desirable steel for a steam boiler seems to be covered by the word "homogenuous," presumably from the belief that the steel will withstand stresses equally well when loaded in the direction of rolling or transversely. Ordinarily the assumption is not strictly true. The variation ranges from 2,000 to 8,000 lb. less per sq.in. when loaded transversely than will be found in a sample taken from the same part of the plate and loaded in the direction of rolling. In the use of boiler plate it may prove of much importance to keep this fact in mind. A plate transversely loaded is more likely to break around the grain boundaries than under a load placed in the other direction.

Boiler steels may be defined as products resulting from a combination of iron carbide and ferrite in an "interstratified" manner. The grains are usually about 0.0005 to 0.005 in. across the borders and usually somewhat flattened in the direction of rolling, with a tendency to induce a degree of parallelism of grain boundary that seems to be the cause of the reduction of transverse strength.

Relative to the forming of plates for shells, drums and straps, Mr. McCabe discussed the case of a boiler that had developed cracks in the outer butt strap and in the doubling plate on the tube ligament. The boiler in question was of the cross-drum horizontal water-tube type, with 7,220 sq.ft. of surface. The drum was 48 in. inside diameter and 13 ft. 4½ in. long. The drum plate was $\frac{15}{16}$ in. thick and the butt straps and doubling plate were ½ in. thick. For riveting, the $\frac{15}{16}$ in. holes were of 3½-in. pitch in the outer row and 7-in. pitch in the inner row, both for doubling plate and the joint. The efficiency of the joint was 73.2 per cent.

Several cracks were found at the rivet holes of the outer strap, and about 26 rivet heads were broken and dropped off from light blows. A study was made to determine the cause of the condition found.

Conclusions Reached by Mr. McCabe

1. Where cracked plates are found the prime cause will be discovered in the design and workmanship.

2. Caustic soda will contribute to and hasten the cracking of already overloaded metal. The presence of the caustic elevates the transmission temperature seriously and may precipitate a failure already at a balance.

3. In long joints the plate is often loaded transversely as rolled. With such loading it may be expected that many failures may be around the grain boundaries.

4. When caustic or other precipitate is found between the plates of a joint it is clear evidence of the existence of the possible condition cited in Item 3.

5. It is not good engineering to design a structure wherein a most important part is strained to the yield point.

In the formation of a drum of 48-in. internal diameter from $\frac{15}{16}$-in. plate, a sheet (48x3.1416) + 0.6875 in. = 151.5 in. wide would be taken for rolling. In this rolling the outer surface of the drum elongates to a circumferential length of 152.367 in., while the inner surface shortens to a length of 150.796 in. The outer surface lengthens 0.867 in. and the inner surface shortens 0.704 in. To strain the outer surface to the yield point, it would be elongated only about 0.1526 in. The neutral axis, or center of the plate, remains unchanged in length.

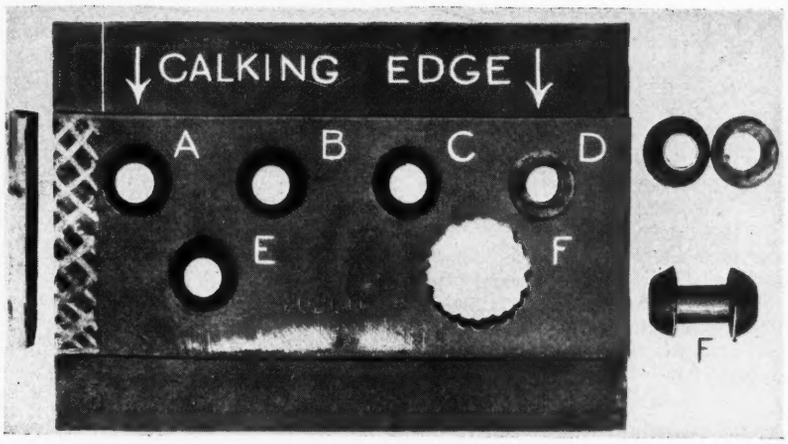
These conditions also result in the forming of butt straps and doubling plates. About 80 per cent of the rivet holes inspected were elongated about 0.010 in. girthwise. The length of lap was two inches from the edge to the center of the rivet, an excess over code limits. It was evident that the outer butt strap and doubling plate were strained beyond the yield point by the calking, that the outer rows of rivets were strained beyond the yield point and that the inner surface of the plate and the outer row of rivets had a residual load up to the yield point without any internal pressure.

To check up on this apparent condition of stress, a test sample of the same design of joint was made by a boiler manufacturer with exceptional facilities and well known for excellence of workmanship. The sample was made from ½-in. plate backed on a plate one inch thick to give the stiffness found in the shell. The sample was fifteen inches long and ten inches wide. The rivet heads were finished to a length of 2.821 in. over heads. To facilitate measurements the rivet tops were made $\frac{15}{16}$ in. diameter. After finishing the rivet ends the plate was calked to simulate the calking on the drum previously mentioned. It was found that rivet *A* in the accompanying illustration increased in length on the joint side 0.015 in. and on the back 0.003 in.; rivet *B* increased 0.013 in. in the front and 0.004 in. on the back; rivet *C* increased 0.015 and 0.005 in., respectively, and likewise rivet *D* increased 0.013 and 0.002 in. Rivets *E* and *F* in the back pitch did not change.

It was found that the calking induced a permanent set in the surface of the plate and that there was a residual stress in both the outer row of rivets and the strap without any internal load. The curvature of the plate, measured three inches from the calking edge, conformed to the arc of a circle whose radius was about 40 in.

A piece of the plate 1¼ in. wide was cut off to observe the change due to release of load. This piece was taken from the end *A*, where a reading of curvature gave a deflection of 0.018 in. in a chord length of two inches. On release the deflection was 0.011 in. In the deflection of 0.018 in. the arc of curvature of the plate was about 33⅓ in. radius, and after release the radius of curvature was about 45.5 in. Taken at a distance of three inches from the edge, these radii would be greater and the stress less.

The rivet *F* in the second row of rivets was cut out by drilling and the metal between the heads turned out. The rivet lost 0.001 in. in length. This



Test sample of joint made to check conditions found in boiler

shortening in 1½ in. indicates a residual load or stress of about 20,000 lb. per sq.in. of rivet section.

Rivet *B* in the front row was removed and the rivet shortened 0.002 in., indicating a residual load of about 40,000 lb. per sq.in. for a rivet having an elastic modulus of 30,000,000.

It appears that if a deflection of 0.003 in. ½-in. plate is exceeded in a length of two inches from the calking edge of the plate, the yield point will be reached. A deflection of 0.004 in. in three inches reaches the yield point.

It will be seen that in a joint where the calking causes deflections or bends of the plate along the outer row of rivets, the plate in all probability will be strained to the yield point. In the test sample and the drum under investigation, the bending was four to five times the amount that would strain to the yield point. The elastic properties of the steel leave a residual stress in the plate.

For a given bend at the rivets, the stresses increase with the thickness of the plate. The inner surface of the calked edge of the strap was strained in compression beyond the yield point in rolling. The calking reverses this and puts it in tension well beyond the yield point. An examination of the rivet hole *D* in the test sample disclosed that it had been enlarged "barrel" shape by 0.001 in. at the bottom, 0.0125 in. at the center and 0.005 in. at the top of the hole. This is customary.

It may be pointed out in the case of the strap with the calked edge that any tension load put on it must be carried by that portion of the plate already loaded to the yield point. That portion of the plate along the approximate line of rivet centers and on the external surface and extending to the neutral axis is in compression and therefore cannot take a load. It must be evident that that region of the strap usually found cracked is constantly loaded to the yield point.

In one boiler in which the plates had been cracked, Mr. McCabe had found temperature differentials of from 60 to 80 deg. F. between the strap and the shell plate, accounting for a possible internal stress of from 11,000 to 15,000 pounds.

Experiments disclosed that with a 40 per cent caustic soda solution the boiling point was elevated 40 deg. F.; for sodium sulphate, 2 deg. F., and for sodium carbonate, 6 deg. F. A tension coupon in a caustic soda solution having 52 oz. to the gallon of water, loaded to 50,000 lb. per sq.in., lost 335 mg. in six days, while a similar sample in the same solution with the same exposure, but not loaded, gained 30 mg. in the same test. The sample broke at the lower end, apparently from reduction of strength due to elevated temperature. A Bunsen burner was used and placed under the test unit to approximate ordinary practice.

In a double-covered butt joint the probability of an explosion from the cracking of the outer strap is remote.

It must be kept in mind that the assumption that under A.S.M.E. Formula P-180 a factor of 5 is obtained, is not true. It is only an average. The loads are concentrated at the rivets. In the driving of the rivets the holes are invariably strained beyond the yield point under the whole head area. This throws the adjacent portion of the plate into tension and reduces the ability of the structure to carry a load safely. A condition is produced where both surfaces are elongated under the rivet; a tension stress set up longitudinally near rivet holes, and then, after calking, an added stress is set up from the calking on the inner surface of the calked plate and an unloading of the external surface when it is put in compression.

The magnitude and effect of temperature stresses is seldom appreciated. These stresses may amount to about 195 lb. per sq.in. per degree difference Fahrenheit. The presence of sodium hydroxide in a joint will surely raise the temperature differentials between the plates. In a test made several years ago to determine the temperature differential of three ½-in. plates riveted together, it was found that a difference of 50 deg. F. existed. The plates were clean. A temperature of 500 deg. F. was maintained in a gas-fired muffle furnace. Water was boiled in a pan formed by the top surface of the riveted plates.

In another case of a bent-tube boiler, a lower drum was found cracked 20 in. girthwise due to a temperature differential of 150 deg. F. between the top and bottom of the drum. The apparent stress was above 30,000 lb. per square inch.

Caustic soda will at times cause corrosion. The speaker had measured a current of 30 milliamperes in a test unit having an area of 15 sq.in., while the caustic was going into solution. The flow ceased when the solution was completed. These phenomena repeated upon boiling to dryness and renewing the solution.

The inference naturally is that riveted boiler joints must go. It was Mr. McCabe's expressed opinion that the use of welded joints in boiler drums was inevitable.

Heating Plants Do Not Plan Use of Higher Pressures, Says Report

LITTLE tendency toward the use of higher pressures in steam-heating plants is indicated in the replies to a questionnaire recently submitted to a group of typical companies by the station operating committee of the National District Heating Association.

Not one of the eight plants about which this question was asked is actively contemplating any shift to higher pressures, despite the fact that several of them are generating considerable by-product electric energy by the steam exhausted to the heating system.

The highest pressure reported is that of the Rochester Gas & Electric Corporation's steam department. Their steam-heating plants "have proved the economy of the 380-lb. class. Any new plants will be equipped with boilers of at least that pressure. On the other hand, the Northwestern Electric Company, of Portland, Ore., is using a pressure of 235-lb. in its heating-plant boilers and feels that no increase is warranted. It is securing twenty kilowatts per 1,000 lb. of steam by its byproduct generation, equal to that of the Rochester plant. The Union Electric Light & Power Company, of St. Louis, Mo., is using a boiler pressure of 200 to 250 lb., and, after giving some thought to higher pressures, has discarded the plan as "not having any specific economic merits." The Allegheny County Steam Heating Company, of Pittsburgh, Pa., has neither used nor considered pressures above 250-lb. The Akron Steam Heating Company whose boilers are designed for a pressure of 400 lb., are operating at a boiler pressure of 125 lb. This company generated no byproduct electric energy.

Neither the New York Steam Corporation, of New York City, nor the City of Winnepeg Central Heating Division is contemplating any shift to higher presusres. Generating equipment at the Winnipeg plant is maintained for stand-by service only. The heating plant of the Philadelphia Electric Company is being operated at 140 lb., although it can use 200 lb. if conditions warrant.

FROM AMONG READERS' PROBLEMS

Conducted By L. H. Morrison

SOOTY BOILER TUBES—*For several years we have experienced a great deal of trouble with our boiler flues and stack sooting up, which frequently burns out. Naturally, this causes considerable concern, not only as a fire hazard to neighboring property but because of the damaging effect it has on the stack and the boiler front, due to the excessive heat generated while burning out. We have tried various methods to eliminate this, but without much result. The coal we are burning is a fair quality, coarse steam coal. Due to the fact that the boiler is a Scotch marine, we are unable to use any kind of an automatic stoker and must fire by hand. Could you suggest a remedy?* B. D. C.

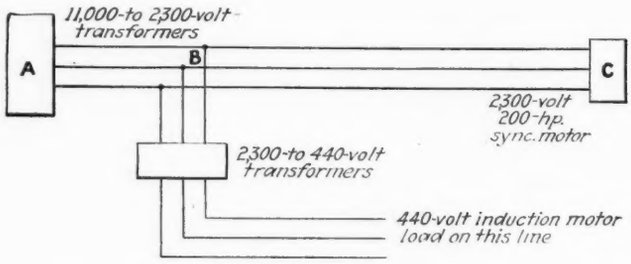
While the use of a soot blower would help materially, the fact that you have so much soot is indicative of poor combustion conditions. Not only are these conditions causing you annoyance from the soot, but you are wasting a lot of coal.

My suggestion would be that you have your fireman fire lightly and often, and that you install a steam jet just over the furnace door, to be operated when the fireman puts on a fresh charge of coal. By producing turbulence above the fire the jet will promote better combustion.

CORRECTING POWER FACTOR WITH SYNCHRONOUS MOTORS—*The diagram shows the general layout of the motor load in our plant. The 200-hp. synchronous motor is on the 2,300-volt line alone. All the other motors are of the squirrel-cage induction type and operate on 440 volts, as indicated. These motors have a total capacity of about 50 hp. The power factor of the system is quite low. Does the 2,300-volt synchronous motor help the power factor of the induction motors? If we install an air compressor that requires about 50 hp. to drive it, would the power factor of the induction motor load be improved if a 440-volt synchronous motor were used?* L.W.R.

You cannot improve the power factor of induction motors except by improving the load conditions under which they operate. For example, an induction motor operating at 50 per cent load may have a power factor of 0.65, where at full load the power factor may be 0.85 or higher. What a synchronous motor, or any other device for correcting the power, does is to improve the power factor of the load.

On the line between where the 440-volt load connects at *B* and the 200-hp. synchronous motor *C*, the power factor is that of the synchronous motor. On the line between where the 440-volt load connects at *B* and the 11,000-volt transformers *A* the power factor is the result of that of the synchronous motor and that of the induction-motor load. The synchronous-motor load is so much larger than that of the induction-motor load, that the power factor of the 11,000-volt transformer must be high even if the induction-motor-load power factor load is low.



General layout of the transformers and the motor load

By adding a synchronous motor to the load supplied by the 2,300- to 440-volt transformers the power factor of this load will be improved. Since this motor has a capacity nearly equal to that of the induction motors, it should bring the power factor fairly high for the load on the 2,300-volt transformers. Improving the power factor of this load will also improve the power of the main transformers. If the power factor of the synchronous motors is allowed to become leading it is possible to obtain a leading power factor on the main transformers. Adjustment of the power factor of the synchronous motor will depend upon the condition under which the system operates. If power is purchased and there is a power-factor clause in the rate, the conditions may be entirely different than if this clause is omitted.

PREVIOUS QUESTION

DISCUSSED BY READERS

THE QUESTION

WE HAVE a centrifugal pump that was designed to handle 300 g.p.m. against a 100-ft. head, direct connected to a 1,750-r.p.m. motor. Can we run the pump against a 50-ft. head? What alterations are necessary?

A. M. P.

THIS pump can be run against a 50-ft. head. The results of lowering the discharge head and the changes necessary depend largely on the characteristic curve of the pump impeller. Lowering the discharge head to 50 ft. will increase the capacity of the pump to somewhere between 500 and 550 g.p.m. The efficiency or ratio of water-horsepower to motor input will likely be lowered somewhat, and the horsepower required to drive the pump will probably be increased. It may be sufficient to overload the motor. All of these changes in performance will take place, but the degree of change will depend entirely upon the performance characteristic of the pump in question.

The simplest and easiest way to take care of the situation would be to partly close the valve at the discharge of the pump, causing the discharge to be throttled. This throttling could be sufficient to maintain the original 300-gal. capacity, which would maintain a 100-ft. head on the pump itself but one of only 50 ft. on the discharge side of the valve, or the valve could be throttled just enough to prevent overloading the motor, which would probably permit the pump to deliver somewhat more than 300 gal. at a better overall efficiency than obtained by throttling sufficient to maintain the original conditions. This method would be inefficient at best, but would prevent overloading of the motor.

The motor speed could be reduced, but if this is an alternating-current job the next lower motor speed, which is 1,150 r.p.m., would not give sufficient head with the present impeller. About 1,250 r.p.m. would be necessary.

Probably the cheapest, most efficient and most practical way of making this

change, provided it was found that the motor was overloaded at the lower head, would be to order a new impeller from the pump manufacturer. It would be possible to obtain an impeller to give 300 g.p.m. at 50-ft. head with only slightly reduced efficiency and requiring considerably less horsepower. Or the manufacturer could supply an impeller to take full advantage of the motor-horsepower available, giving higher capacity and fairly good efficiency at the low head, with a reasonable margin of safety for the motor.

A. L. FREULER,
Union Steam Pump Sales Co.
St. Louis, Mo.

THE RESULT of reducing the head on a centrifugal pump is to increase the amount of water pumped, usually to a point where the load is too great for the motor. The head can be varied by changing the motor speed or the impeller diameter. In the case of a 1,750-r.p.m. motor, if it is a 60-cycle a.c. machine, the speed cannot be changed.

The pump manufacturers will be glad to supply a new impeller for this pump, for the lower head or the impeller can be cut down in diameter by a trial-and-error method until the proper size is found.

The pump can be operated at the lower head but at a reduced efficiency by throttling it by means of a valve on the discharge, keeping the 100-ft. head on the pump and reducing the amount of water pumped. This is wasteful of power, however, as with the proper-sized impeller or the right speed for the original impeller the 300 g.p.m. can be pumped 50 ft. for about half the power required to pump it 100 ft.

E. A. ROBERTS.
Carlsbad, N. M.

THE QUESTION can be answered in the affirmative. We have a pump in our plant driven by a constant-speed motor and designed to operate at 100 lbs. pressure, but because of the excessive demand on the pump, the actual pressure is only 50 lbs. Although the pump apparently was properly designed and balanced at 100 lbs. pressure, when first put to work at 50 lbs. pressure the ball-bearing thrust heated up considerably and eventually the balls burst. This difficulty was overcome, however, by moving the sealing rings and the impeller in the housing to compensate for the thrust. No further alterations were necessary.

However, before attempting to operate a 100-ft. pump at 50-ft. head one should learn from the pump manufacturer what power will be consumed by the motor at the reduced head. The power consumed by many pumps increases greatly as the pressure on the pump is decreased. The pump in question might possibly burn up the motor at only 50-ft. head on the pump.

RAYMOND F. FORBES,
Indianapolis Power & Light Company.
Indianapolis, Ind.

ALTHOUGH it is possible to run the pump against a 50-ft. head, as it is now arranged, better results will be secured by replacing the motor with one of slower speed.

If operated without alteration against a 50-ft. head, the pump will throw a greater quantity of water and will consume more horsepower, which will result in overloading the motor. This can be prevented by partly closing the discharge valve on the pump to produce a condition similar to operation against the 100-ft. head. By keeping the quantity handled at 300 g.p.m., the horsepower is maintained practically the same as when pumping against the 100-ft. head.

A slower speed motor of fewer horsepower would save considerable power.

ROBERT P. O'BANNON.
Louisville, Ky.

A Question For Our Readers

WE HAVE three pulverized lignite fired boilers in our power plant and are endeavoring to keep a record of the hours during which each boiler is in operation, unavailable, banked or idle. As a result, two questions have come up:

1. *When is a pulverized-fuel-fired boiler "banked?"*
2. *What, if anything, do the terms "live bank" and "dead bank" mean?*

Suitable answers from readers will be paid for and published in the Aug. 20 issue.

WE ARE using a standard make centrifugal pump designed for 250 ft. head, 350 g.p.m. at 3,600 r.p.m. as a sinking pump. This pump handles the water from a mine shaft at any head; the discharge is throttled sufficiently at very low heads to maintain sealing water on the glands. Necessarily, the efficiency of the pump at low heads is greatly reduced. Unless the suction is oversized, a pump will deliver very little more than its rated capacity, even at very low heads.

S. H. PEDEN.
Mill City, Nev.

SOME types of centrifugal pumps are so designed that the brake-horsepower required under any head will never exceed that required at the normal head for which the pump was designed. With this type of pump, it would be feasible to operate at 50-ft. head even though the pump has been designed originally for 100-ft. head.

Certain other types of centrifugal pumps, however, when operating at reduced head will require more power, and there is a danger of overloading the motor. In such cases the problem can be solved by throttling the discharge from the pump so as to create an articial head, which will prevent overloading. A pressure gage should be installed between the pump discharge and the throttling valve so as to be able to determine the head on the pump.

C. J. SNOW.
Saint Paul, Minn.

WITH rearrangement the pump can be run on a 50-ft. head. The fundamental equation of the centrifugal pump is:

$$V = \sqrt{2gh}$$

where V = speed in ft. per sec. of a point on the periphery of the impeller,
h = head in feet against which the pump runs,
g = 32.2.

Theoretically, the correct way to reduce the maximum head would be to reduce the pump speed and establish the desired impeller velocity.

Since

$$\frac{V}{V_1} = \frac{\sqrt{2gh}}{\sqrt{2gh_1}} = \frac{80.2}{56.7}$$

the new speed would be

$$1{,}750 \div \frac{80.2}{56.7} = 1{,}237 \text{ r.p.m.}$$

If the pump is driven by a steam unit or a direct current motor, this speed reduction would be feasible. However, the speed given indicates an induction-motor drive, and the nearest possible speed would be slightly under 1,200 r.p.m. It is at once obvious that the idea is not practical.

A well designed centrifugal pump will develop 50 to 60 per cent of full torque at full speed with the discharge valve closed. Opening the discharge wide with the head reduced and other initial conditions unchanged might result in an unstable pumping action due to the passage of an increased amount of water through the pump passages, which were designed for a definite flow.

My suggestion is to leave the installation unchanged and throttle the discharge to the point where a steady pressure is maintained. The capacity would be increased somewhat and the efficiency would show a moderate decrease. In any case, the characteristic curve furnished by the manufacturer should be consulted. The unit is too small to warrant extensive redesigning.

JOHN W. WALDENVILLE.
Pittsburgh, Pa.

THE simplest way to use this pump for a 50-ft. head would be to put a restriction in the discharge line to keep the motor from overloading. It will then throw as much water as it did on the 100-ft. lift, but the efficiency will be about 50 per cent of what it was.

It is advisable to obtain the pump's characteristic curves from the builder to ascertain the effect of changing the head.

E. A. MILLS,
Tennessee Copper Company.
Copperhill, Tenn.

HOW TO CAPITALIZE A PATENT

By J. H. DAYDEN
Charleston, West Va.

IT MAY be observed, first, that many men who exercise common sense in other regards become immediately irrational on the subject of patents. This is a general observation and is intended to help dissipate the voodoo cloud that many insist must surround the subject of inventions and patents.

Then, it may be observed that inventions are not incoherently conceived, though they may appear to be. Modern psychology has its basis in the fact (or hypothesis, if you wish) that all mind actions are causative. It is perfectly true that the mind frequently, probably generally, does not trace the causation of its action, so we account for intensive mind action by such phrases as "flashes of genius" or such words as "intuition" or "inspiration." The courts have not been free from insistence that inventions should be "flashes of genius," totally incoherent of tangibility with the past, that might be traced by ordinary minds, and that inventors should have something in common with the astrologer and spiritualist medium. This idea has been refuted time and again by the greatest inventors, especially Thomas A. Edison, whose remark (at least attributed to him) that "inspiration is nine-tenths perspiration" is famous.

It has been said that no one knows just what an invention is. It has never been accurately defined so that even a good patent lawyer could immediately render an opinion as to whether or not some new device or process is an invention. The result of this has been that the Patent Office usually issues a patent when a search of the patents of the prior art reveals nothing in conflict to the new claims.

So it is a comparatively easy matter to obtain some kind of a patent on any kind of a machine. All that is necessary is to keep revising the claims until conflict with prior patents is eliminated. Design patents and exact formula patents are easy to obtain. Of an entirely different nature are the so-called basic patents, as exemplified by the Wright brothers' first patent on warping the wings of an airplane, or DeForest's basic patent on the audion tube. The details of the design do not matter. In the first case it did not matter how the wings were warped, whether the wings were bent or certain sections hinged. In the latter case it did not matter how the third element, the "grid," was designed, whether flat or spiral or how mounted in the tube. The early patents on steam turbines, internal combustion engines, particularly the Diesel patents, were of the same nature.

Basic patents are few. If the work of the Patent Office were confined to them, no doubt the number of patents issued each year would drop 90 per cent or more. However, design patents are valuable in many cases, and practically all industrial concerns follow up new designs with patents. It should be clear that the patents themselves, detached from the business, probably would have no value whatever to any other concern, but serve as a sensible protection against unfair trade methods.

Therefore, it is hardly worth an individual's time to apply for a design patent. Often a man will apply for a patent for something that he thinks is a basic invention, but the records of the prior art are voluminous and represent the best inventive thought of many lives, so he may find that though he finally has an official patent, with ribbon, seal and everything, it is actually so limited as to possess no business value whatever.

Design patents are generally easy to obtain, but to make profitable use of them is a more troublesome matter. Some of the difficulties that confront the man with a patent and how these may be faced and overcome are here related.

So it is that the path of the man with a patent is beset with difficulties. The chances against him are well known. It has been said that only one invention in a hundred has commercial value. So the business man knows that when he blindly refuses to put any money into patents, he will be right 99 times in 100—and that's more than sufficient odds, in his estimation.

I know of one large and very progressive industrial concern that figures only one patent in twenty taken out by it has particular value. The twentieth pays for the other nineteen—and then some. This is with a trained corps of research men.

Of course, it is a case where a man can be right 99 per cent of the time and still be wrong. See what the pitiful 1 per cent has done: nothing less than make modern civilization possible!

In view of all this, what is the best course for a man with a good patent to pursue? If he simply circularizes industrial concerns in an effort to sell his patent, he faces the well-known situation above described. The only other course for him is to prove its worth.

How that can be done depends, of course, on what kind of a patent it is. Usually engineers are interested in patents of devices or machines that will do work better or more cheaply than prior machines. It is suggested that he restrain his enthusiasm and face the facts of the difficulties before him. Usually he thinks he must build his own shop. That should not be necessary. The country has numerous shops looking for work. Of course, the inventor must have his drawings, patterns, special tools. In general the cost of these should be within the reach of one who has saved systematically. That in itself is one test of him. If he has not saved anything, unless he is very exceptional, he has no chance whatever, for the success of his invention rests upon its improving industrial economy—it must save something or make life better in some way.

He may object that the shops want too much money to make his machine. This he should carefully examine, for his tendency will be to far underestimate the cost of manufacturing his device. Perhaps the cost of manufacture can be greatly lessened when he gets it into production. Information on that should be readily available to him, and he should not be afraid to pay for honest opinions of competent men on such points.

If his little company cannot stand a fairly high initial shop cost, which is compensated by low overhead to some extent, the test must be fairly met.

Then as to selling. Must he have his own selling organization, perhaps with inexperienced salesmen calling on the trade? There are selling organizations already in existence which might be induced to handle this machine along with other devices, thus greatly reducing the cost of distribution. Even so, the inexperienced inventor may be appalled by the usual marketing costs. He should face those facts also. In fact, his success in the whole matter depends upon how quickly he faces the facts and bases his decisions upon them.

The last observation may be that he should suppress false pride, which might cause him to stick to a sinking ship until too late. He must be ready to be the first to admit that he was wrong, and to recognize the right or best course, though it may mean the abandonment of some of his dearest ideas. Usually he finds that the final outcome of his work is quite different from anything he started with. In fact, he may branch off into a line that does not seem to be at all related to his first idea, and the branch may become the main line.

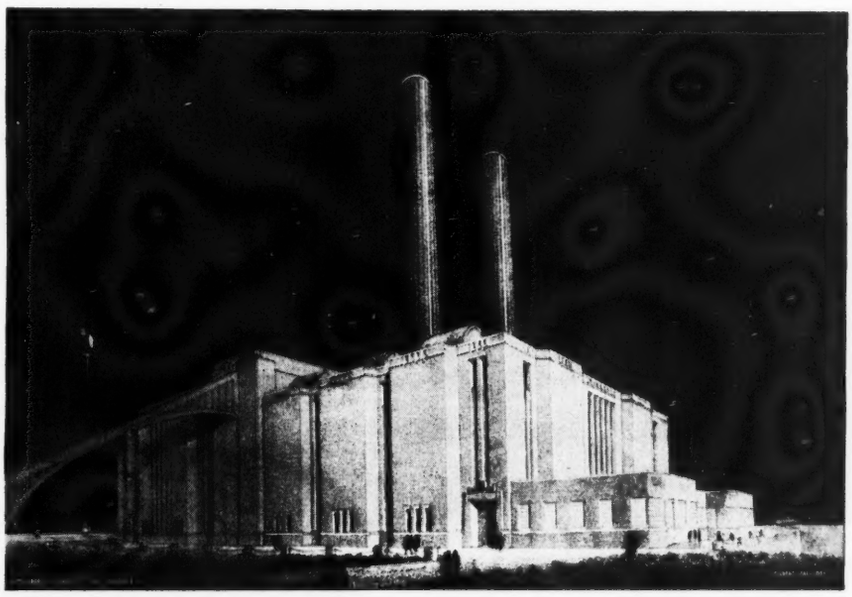
Then when he has made a success on a small scale, a very small scale, he can take the thing to a business man, and that business man can understand simple arithmetic. He has something of demonstrated value, and he has a bright chance either to sell it or to organize a company in which he can obtain capital on reasonable terms.

As engineers, we do not all have to do the work of James Watt, or Parsons or Faraday over again. We profit by their thought and experience. But in this matter, as in similar ones, the tendency seems to be for everyone to find out for himself. Even if the inventor insists upon doing so, he will be far richer in experience, and the real test is whether he will utilize that experience to a greater extent than he utilizes the experience of others.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

Construction Started on Plant for Michigan City



Architect's sketch of Michigan City Plant

FINAL plans for the large electric generating station to be built on the lakefront at Michigan City, by the Northern Indiana Public Service Company have been made public. The plant, which will be completed and ready for operation in the spring of 1931, will cost in the neighborhood of $9,000,000. Herlihy Brothers, of Chicago, have been awarded the general construction contract. Holabird & Root, of Chicago, are the architects; and the engineering design of the station is the work of Sargent & Lundy, Chicago.

The building, which is to be 405 ft. long and 155 ft. wide, will be large enough to house two turbine-generator units, although the initial installation will be one unit of 68,000 kw. capactiy. Other units will be added as the power requirements of the district increase, the station being designed to provide for further expansion in the future. To the crest of the roof will be 114 ft., and to the top of the stack 250 ft.

Construction plans also call for erection of a breaker house for pulverizing coal, two conveyor bridges through which the pulverized fuel will be moved to the plant, a scale house and pit, a track hopper, foundation piles, and an intake tunnel and discharge flume for lake water used in condensing steam. Work has already started on a gate house at the entrance to the property. It will also be used as construction headquarters.

The site of the station is on the lakefront directly west of the Michigan City harbor. Approximately 85 acres are included in the tract, purchased by the company four years ago.

World's Potential Power Will Be Estimated at Conference

The problem of estimating just how much potential power is stored up in and on the earth's crust is one of the ambitious tasks that the World Power Conference, meeting next year in Berlin, Germany, has set for itself.

Preliminary surveys of the world's power show that the United States leads in resources of coal, oil and water power. At the World Power Conference in 1924 it was estimated that the total coal reserves of the earth, including anthracite, bituminous and "brown" coal were 7,397,533,000,000 metric tons. Five-sevenths of this total was held to be in North America.

In oil resources, according to O. C. Merrill, head of the American section of the power conference, North America also leads, but with a much smaller margin. The United States has 16 per cent of the world's oil supply, and Russia and northern South America each have slightly over 13 per cent. The total for the world is estimated at 43,055,000,000 barrels.

At the 1924 conference a tentative estimate of the world's supply of water power was also made. The figure set at that time was 138,000,000 kw. Even when the conference revises its estimate next year on the additional data gathered, there will be half a dozen other potential sources of power that are only beginning to be explored and have not yet reached practical significance, such as solar radiation, energy from air currents, energy from temperature, differences between the Arctic regions and the equator, and atomic energy.

A.S.M.E. Officers Nominated

The nominating committee of the American Society of Mechanical Engineers, which held its final meeting in Chicago on July 8, has proposed the following names for next year's officers of the society: President, Charles Piez, chairman of the board of the Link Belt Company, Chicago; vice-presidents, Paul Doty, Ralph E. Flanders, Ernest L. Jahncke and Conrad N. Lauer; managers, H. B. Coes, James D. Cunningham and C. F. Hirshfeld.

Survey Shows Many Activities of American Engineering Council

Constructive effort by the American Engineering Council in shaping the engineering attitude toward public questions is reported by Executive Secretary Lawrence W. Wallace in a statement summarizing the council's recent activity. The engineering mind, Mr. Wallace points out, is progressively influencing legislative and administrative action. The council, he says, is now nationally recognized as a positive force in federal affairs. Mr. Wallace enumerates some of the outstanding accomplishments of the council, organized under the headship of Herbert Hoover in 1919, and outlines important projects with which the council must immediately deal.

Besides going forward with respect to legislation and administration, the council's character as a responsible investigation body in the sphere of engineering has been definitely established. The council also acts as a clearing house in Washington for the engineering and allied professions. The council enables engineers everywhere to maintain close contact with federal activities. This phase of the council's work is continually broadening, and will in the future form one of the most significant services which the council affords to engineers.

The council, through the engineering and scientific press, and through the newspapers and general periodicals, keeps the engineer in the forefront of public thought and public discussion.

The council took a leading part in the legislation affecting Boulder Dam. It opposed the original measure known as the Swing-Johnson bill, and subsequently appointed a committee which issued a report stating that the information on hand was not conclusive as to the engineering feasibility of the plan outlined in this bill and that before either the government or private capital would be justified on engineering or economic grounds in committing themselves to the expenditure involved a thorough investigation should be made.

The council has consistently supported the movement to establish a national hydraulic laboratory. For seven years the engineers of America have been working for the establishment of such a laboratory in the United States Bureau of Standards. Farley Osgood, I. E. Moultrop and Charles Penrose constitute a council committee to further this project.

As a result of the study and activity of the interdepartmental board on contracts and adjustments, established by the bureau of the budget, there was introduced into Congress by Mr. Cramton a bill providing for the establishment of uniform requirements affecting government contracts.

Australian Colliery Group Erects New Power Plant

Recently the Caledonian Collieries Company, of Newcastle, New South Wales, completed the erection of a power station suitable for its own collieries' requirements and for supplying a number of outside consumers. This power station takes the place of a number of medium-sized plants, each located at the particular collieries. The installation of the central plant has greatly reduced generating costs.

The present installation includes two 5,000-kw. turbine-alernators generating 3-phase, 50-cycle current at 6,600 volts. Steam is supplied by two C.T.M. boilers, each with a heating surface of 8,619 sq.ft., fitted with superheaters having a surface of 2,240 sq.ft. and Green's tritube economizers of 4,874 sq.ft. The condensing water gravitates from Cockle Creek through the necessary screens to circulating pumps, then through the condensers, and is discharged by a gravity race into an adjacent swamp.

The boiler plant has been arranged for economical firing, with low-grade fuel, and, as large quantities of unsaleable pit waste are available adjacent to the station, the generating costs are low. Moreover, in the event of industrial trouble, continuity of operation is thus assured. An unfailing supply of fresh water suitable for boiler feed without treatment is available. The conditions as to fuel supply, condensing water, fresh water, etc. indicate that this undertaking should grow.

Spot * News

THE ENTIRE STEAM *requirements, amounting to more than 1,500,000,000 lb. annually, of the Grand Central group of buildings, covering twenty city blocks in New York City, are to be supplied by the New York Steam Corporation, according to recently completed arrangements.*

* * *

PRODUCTION *of fuel briquets in 1928 was 947,423 net tons, valued at $7,705,617, according to reports furnished to the Bureau of Mines by operators of briquetting plants. In comparison with 1927, the production showed a decrease of 2.4 per cent, but in comparison with 1925 an increase of 12.9 per cent.*

* * *

A CAST ALLOY *of the tungsten-carbide type, said to be more uniform than the alloys made by sintering, has been developed for use as a cutting tool. The new alloy, which is known as "Haystellite," has been used successfully as a diamond substitute for oil well bits and for drawing dies.*

* * *

WITH THE RECENT *addition to its apparatus of a pneumatic coal-cleaning table, the Northwest Experiment Station of the Bureau of Mines, at Seattle, Wash., becomes one of the most completely equipped laboratories in the country for conducting studies of coal-washing problems. Its equipment now includes all the principal types of wet and dry cleaning apparatus.*

* * *

IT IS EXPECTED *in financial circles, that the Philadelphia & Reading Coal & Iron Corporation will modernize its mines and erect a power plant at Herndon, Pa., on the Susquehanna River, twelve miles south of Sunbury. Pulverized anthracite, the small sizes of which are a byproduct of the company's collieries, will be used as fuel in the new plant.*

* * *

THE COLLEGE OF ENGINEERING, *Copenhagen, Denmark, which is at present constructing extensions to triple its present capacity at the end of August, will celebrate its centenary by holding a congress of Scandinavian engineers. About 1,000 visitors are expected to attend.*

* * *

FEWER INDUSTRIAL DISPUTES *occurred in the United States in 1928 than in any year since the Bureau of Labor Statistics of the Department of Labor began its compilations in 1916, according to a statement just made public by the bureau. The total number reported in 1928 was 829, involving 357,145 workers.*

Construction Progresses on Three Power Plants

Rapid progress is being made on three engineering projects for utility companies in the Standard Gas & Electric Company system. Largest of the three is the 60,000-kw. plant of the Duquesne Light Company on Brunot Island, Pittsburgh, Pa. The building now under construction will be large enough to house two 60,000-kw. generators and six boilers, although only one generator and three boilers are being installed initially. Back filling in the south wall of the turbine room basement is now in progress and all column-bearing plates in certain sections of the station have been completed. The section of the intake tunnel between the new screen house and the power station is now complete, and work on the screen house well under way.

The new 15,000-kw. station of the Oklahoma Gas & Electric Company, of which Enid, Okla., is the operating headquarters, is scheduled for operation on Feb. 1, 1930. The plant will use a steam turbine, and it will be completely modern in electric generating equipment, including superheaters, preheaters and evaporators to purify feed water.

The 10,000-kw. addition to the Mountain States Power Company's Coos Bay Station at North Bend., Ore., is scheduled for completion July 1, 1930. Of the two boilers that will be erected to supply steam for the turbine, one is now being built. Erection of the superheater and the structural steel work also has been started.

Proposed Tariff on Crude Oil Draws Many Protests

Decided objection to any tariff on crude petroleum or its products was voiced before the Senate Finance Committee recently by civic and commercial interests using oil for fuel, and by the American producers of oil in foreign fields. This protest followed a proposal by the Mid-Continent Oil & Gas Association, offered as an amendment to the tariff bill by Senators Pine and Thomas, of Oklahoma, to place a duty of $1 per ton on crude oil and 50 per cent ad valorem on refined petroleum.

Representatives of industrial groups and civic bodies in Georgia, Maryland, Massachusetts and other seaboard states expressed the belief that duty-free oil is essential to economy of operation and industrial development. J. B. Klumpp, representing the American Gas Association, testified that petroleum or its products is used in the production of about 61 per cent of all the city gas made in the United States, and that a 12c. increase in the price of gas per 1,000 cu.ft. on the Atlantic seaboard, and an increase of 20c. per 1,000 cu.ft. on the Pacific coast, would be the result of such a tariff.

Conservation of the domestic supply of petroleum was advanced as an argument against import duty by American

companies producing petroleum abroad. Such a duty would inaugurate an extensive wild-catting campaign that would cause further depletion of oil reserves in this country, H. Walker, representing the Pan American Petroleum Company, New York, pointed out. The duty proposed, he said, would cost American consumers $200,000,000 each year, almost half of which would fall on American ships and railroads.

A tariff on oil would make it very difficult for American companies to ask foreign governments for concessions, John S. Weller, representing the South Penn Oil Company and the Penn Mex Fuel Company, declared. Explaining that foreign crude is refined in this country, he contended that there was no essential difference between American companies operating in foreign fields and American companies operating in domestic fields except that the former conserve the domestic supply by bringing the foreign oil into domestic competition.

It was pointed out by the opponents of the proposed tariff that the entire success of the the oil burner as a heating plant depends upon the maintenance of a low price for fuel oil.

U. S. Engineers to Attend Mexican Convention

A large number of visiting engineers from the United States and Canada will attend the convention of the Centro Nacional de Ingenieros Mexicanos, to be held at Mexico City on August 26, 27 and 28. The American Association of Engineers has taken the initiative in making plans for the trip, and has arranged for a group to travel to Mexico City from El Paso in a body.

The Mexican engineers have outlined an interesting program of entertainment for their foreign guests. The party will return from Mexico Sept. 3, giving visitors the opportunity to visit points of interest. All necessary information in regard to rates, reservations, etc., can be obtained from the American Association of Engineers, 8 Michigan Ave., Chicago, Illinois.

Orders Placed for Big Plant on Severn River, England

The West Midlands Joint Electricity Authority of England has just placed an order for the complete electrical generating equipment for the first section of the new base-load power station being erected at Ironbridge, on the River Severn. Included in the contract are a 50,000-kw. turbine-alternator, three 21,000-kva. outdoor-type transformers, 33,000-volt switchgear, and the necessary auxiliary equipment.

The turbine-alternator consists of a 50,000-kw. two-cylinder, double-flow steam turbine directly coupled with a three-phase 11,000-volt 50-cycle alternator. The turbine is designed for a steam pressure at the stop valve of 375 lb. per sq.in. gage and 750 deg. F. temperature.

Connected with the alternator are three single-phase, outdoor-type transformers arranged in delta on the primary side and star on the secondary side, giving 33,000 volts between phases. These transformers will be the largest self-cooled units ever manufactured in Britain for power station service.

The main power station switchgear is of the remote, electrically operated, duplicate busbar, oil-insulated, vertical plugging, metal-clad type suitable for 33,000 volts and fitted with oil circuit breakers having a rupturing capacity of 1,500,000 kva.

Men in the News

RAY P. STEVENS,

president of the Allied Power & Light Corporation, has been named president of the Niagara Hudson Power Corporation, recently organized from the merger of the Buffalo, Niagara & Eastern Power Corporation, the Northeastern Power Corporation and the Mohawk-Hudson Power Corporation. Mr. Stevens has for many years been active in the operation and management of public utility properties in various sections of the country and last year, when the Allied Power & Light Corporation was formed from the consolidation of Hodenpyl, Hardy & Company, Inc., and Stevens & Wood, he became president of the new organization, after having served as chairman of the board of Stevens & Wood.

Polytechnic Society Will Aid Engineers and Scientists

Over eighty charter members are enrolled in the newly organized Polytechnic Society of New York City, which has now taken a place with other technical associations in enabling specialists in various lines to exchange ideas. Five meetings have been held since its inception, and several visits to places of scientific interest have been made. About half of the members are in the faculties of Columbia University, New York University, Fordham University and City College of New York. The corresponding secretary of the organization is Robert Grimshaw, of 65 Jesup Place, Bronx, New York City.

West Texas Utilities Co. Enlarges Power Plant

The San Angelo plant of the West Texas Utilities Company is to become the largest generating station of the company by the spring of 1930, it was recently announced from the general offices of the company at Abilene, Tex. Installation of a 20,000-hp. steam turbine-generator, to be delivered in November, is to increase the generating capacity of the San Angelo plant from 15,000 to 35,000 horsepower.

Addition of the new unit will mean an enlargement to the building and an addition to the sub-station of the plant. The boiler room will be extended 25 x 115 ft. and the switch room will be extended 40 x 50 ft. When the new unit is in operation the West Texas Utilities Company will have an available electrical energy of 105,000 hp. In addition to the big turbine-generator, ordered from the Allis-Chalmers Manufacturing Company, of Milwaukee, there were ordered two boilers from Babcock & Wilcox Company, of New York.

Increase in Diesel Ships Weakens Radio Law

An interesting sidelight on the increasing use of Diesel and other internal combustion engines for ships has been brought to light by the legal department of the Federal Radio Commission. The ship act, which requires the installation of radio apparatus on vessels carrying 50 or more people on the ocean or the Great Lakes, refers only to "steamers," and vessels powered by other means cannot be compelled to do so under the present law.

At the time the law was framed and amended, in 1910 and 1912, the word "steamer" was used by Congress to make the act inapplicable to sailing vessels. The various types of sea-going motor ships have had their development since that time and are entirely outside this law. Amendatory legislation to bring the statute up to date is now being urged.

Hydro-Electric Plant May Result From Zinc Demand

The high price of zinc and the large demand for this metal have led engineers and residents of Newton County, Ark., to authorize a survey in regard to the construction of a hydro-electric power plant on the Buffalo River, near Jaspar, Ark. Considerable zinc ore is available in the region, but transportation costs to smelters have made it unprofitable to mine.

The projected power plant would not only furnish the power necessary for

electrolytic refining, but the projected dam would form a reservoir extending a sufficient distance upstream in the direction of the mines to make barge transportation possible.

The proposed dam would be 105 feet high and would form a reservoir covering ten square miles. The plant as planned would be able to supply power not only to the proposed smelter but to the other industries and to the towns located in that section of Arkansas.

Leipzig Trade Fair Will Attract 180,000

The Leipzig Trade Fair, which will be held from August 25 to 31, will, it is expected, attract more than 180,000 exhibitors and buyers from all parts of the world. As it approached its 700th anniversary, this great German exhibit outclasses all other such exchanges in size and volume of business transacted.

All types of apparatus in every industrial field are represented. American participation in the exhibit has increased greatly in the last few years. In the spring fair, the United States sent more than 100 significant exhibits. Special business tours for the convenience of exhibitors and buyers are being arranged. Further information regarding the fair may be obtained by addressing the Leipzig Trade Fair, 11 West 42nd St., New York City.

San Diego Engineers Organize

Organization of the Engineers' Club of San Diego with a charter membership of 85 has been announced. The club will be the voice of the engineering profession in San Diego, will be representative of all branches and will take an active part in civic affairs, according to the announcement. The club, which is only a local organization and not affiliated with any state or national group, will hold monthly meetings. Officers for the ensuing year are: President, E. L. Freeland; vice-president, R. R. Roe; secretary, R. E. Jensen, and treasurer, E. H. Smith.

Crude Oil Engine Market Expanding in Greece

Considerable expansion has been recorded in the market for crude oil engines in Greece during recent years, Assistant Commercial Attaché Ralph B. Curren, Athens, reports to the Department of Commerce. In 1928 the importation of this type of engine on a horsepower basis increased by 52 per cent as compared with 1926, and by 38½ per cent as compared with 1927, to a total of 834 units.

Crude oil engines are popular in Greece, owing mainly to the fact that they have been found cheaper to operate than engines using kerosene and gasoline as fuel. Moreover they are not only employed for industrial purposes but are also used on a large scale for supplying electric light and power to provincial towns.

Coming Conventions

American Institute of Electrical Engineers. Pacific Coast Regional Meeting, Santa Monica, Calif. Sept. 3-6. F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Welding Society. Fall meeting at Cleveland, Ohio, Sept. 9-13. Secretary, M. M. Kelly, 33 West 39th St., New York City.

National Association of Power Engineers, 47th annual convention, Chattanooga, Tenn., Sept. 9-13. Fred Raven, secretary, 417 South Dearborn St., Chicago, Ill.

National Association of Practical Refrigerating Engineers. Twentieth annual convention at the William Penn Hotel, Pittsburgh, Pa., Nov. 4-7. Secretary, E. H. Fox, 5707 W. Lake St., Chicago, Ill.

National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York City, Dec. 2-7. Charles F. Roth, manager, Grand Central Palace, New York City.

Universal Craftsmen Council of Engineers. Annual meeting in Detroit, Mich., Aug. 6-10, at the Book-Cadillac Hotel. Grand Secretary, T. H. Jones, 33 Linden Ave., Cherrydale, Va.

World Engineering Conference, Tokyo, Japan, October, 1929. All correspondence should be addressed to the Secretary, World Engineering Conference, Nikon, Kogyo Club, Morunouchi, Tokyo.

OBITUARY

WILLIAM BAURHYTE, formerly president of the Los Angeles Gas & Electric Corporation and president of the Pacific Coast Electrical Association during 1925-26, died in Los Angeles July 4. Mr. Baurhyte had resigned as executive of the Los Angeles Gas & Electric Corporation on March 31, 1928, to take an extended vacation from business duties. His service with the company dated from Sept. 1, 1903, when he left the Pacific Gas & Improvement Company to become second vice-president of the power company. Ten years later he was elected vice-president, and in 1921, on account of his special experience, he was made vice-president and general manager. He became president in 1924.

PERSONALS

O. C. MERRILL, chairman of the American Section of the World Power Conference, is now located in the Edmonds Building, in Washington, D. C. He will be in Washington until his departure for Japan on October 1.

WALTER E. BRYAN, superintendent of power, St. Louis Public Service Company, was recently elected chairman of the St. Louis section of the A.S.M.E. R. R. TUCKER and ARTHUR T. HUNTER were elected vice-chairman and secretary-treasurer, respectively.

CHARLES GRANT, of St. John, N. B., has been appointed inspector of electricity and gas for that province, to fill the vacancy created by the resignation of R. P. FORTIN.

F. E. BONNER, executive secretary of the Federal Power Commission, left Washington on July 13 for a Western trip. He will be away from Washington until the middle of August. COLONEL MAX TYLER, new chief engineer of the commission, will arrive in Washington on Sept. 16.

M. L. HIBBARD, vice-president and general manager of the Idaho Power Company, Boise, was chosen president of the Northwest Electric Light & Power Association at its recent annual convention in Seattle, Wash. He served as vice-president of the organization during the past year.

A. W. CASH, manufacturer and inventor of valves, has sold the Apex Regulator Company, of Decatur, Ill., to the Fisher Governor Company, of Marshalltown, Iowa. He has signed a five-year contract as engineer with the Fisher Company.

GEORGE H. WALKER, president of W. A. Harriman & Company, and WILLIAM F. CUTLER, vice-president of the American Brake Shoe & Foundry Company, were recently elected to the board of directors of the National Bearing Metals Corporation.

I. B. WALTHER, formerly purchasing agent for the California Oregon Power Company, of Medford, Ore., has accepted a position with the American & Foreign Power Corporation, with headquarters in Rio de Janeiro.

E. B. CRIDDLE, vice-president of the Southern Sierras Power Company and the Nevada-California Power Company, was chosen president of the Pacific Coast Electrical Association at its recent convention in Del Monte, Calif. Mr. Criddle was first vice-president of the association last year.

BUSINESS NOTES

FREYN ENGINEERING COMPANY, of Chicago, Ill., now has fourteen engineers and specialists in the Soviet Republic in connection with the rehabilitation of Russia's iron and steel industry. H. J. Freyn, president of the company, has sailed for Europe and will visit the scene of the work.

PLIBRICO JOINTLESS FIREBRICK COMPANY, of Chicago, Ill., has acquired the property formerly owned by the Portsmouth Refractory Company, of Portsmouth, Ohio. This property in-

cludes 1,200 acres of clay deposits, a completely equipped firebrick plant, and the town of Firebrick.

PERMUTIT COMPANY, manufacturer of water softeners, filters, etc., has opened a new branch office in the Montgomery Building, Spartanburg, S. C. The new office will be in charge of Mr. R. V. Irwin, who for the last six years has been manager of the Permutit Company's office in Chattanooga, Tenn. Mr. Irwin's new territory will comprise North Carolina, South Carolina and the eastern portion of Georgia.

TRANSMISSION ENGINEERING COMPANY, of Philadelphia, Pa., has recently been organized for the purpose of specializing in power-transmission problems. L. H. Shingle will head the new organization. Engineers will be available to any manufacturer interested in securing data on the most economical methods of mechanically transmitting power. Particular attention will be given to the securing of information that will enable machine builders to adapt the drive of their machines to the requirements of different classes of manufacturers. Studies of group drive vs. individual motor drive will be made by the organization.

DIAMOND POWER SPECIALTY COMPANY is now represented in New York City through its own offices located at 12 East 41st St., instead of through the Vincent Gilson Engineering Company, as formerly.

AMERICAN HOIST & DERRICK COMPANY, of St. Paul, Minn., announces the opening of a branch office and warehouse in Los Angeles, Calif. W. H. Lummus will be in charge of this office, which is located at 337 South Anderson Street.

NEWHALL CHAIN FORGE & IRON COMPANY, of New York City, has recently completed negotiations for the purchase of the Rensselaer Chain Works, at Rensselaer, N. Y., together with adjoining properties. The Rensselaer Chain Works has been under the exclusive operation of the Newhall Company for a number of years.

TRADE CATALOGS

PUMPS—Catalog S, recently issued by Goulds Pumps, Inc., of Seneca Falls, N. Y., contains descriptions, specifications and ratings of the various types of pumps that they manufacture. In addition, the booklet contains an engineering data section made up of information useful in figuring suction lifts, heads, pipe friction, horse power, pulley sizes, etc. Many illustrations and charts are included.

VACUUM RECORDERS—The Uehling Instrument Company, 473 Getty Avenue, Paterson, N. J., has published a six-page bulletin, No. 150, describing the Uehling combined barometer and vacuum recorder, for use with steam turbines.

FLEXIBLE COUPLINGS—A detailed description of "kanti-lever" flexible couplings is contained in Bulletin 28, recently issued by the Brown Engineering Company, of Reading, Pa. In addition to descriptions of the couplings, a formula for selecting the proper coupling and a price list are included.

REMOTE CONTROL — "Selsyns," the self-synchronous motors manufactured by the General Electric Company, Schenectady, N. Y., to be used in pairs for remote signaling, control and indication, are described in a bulletin recently issued by the company. The theory of operation and industrial applications of the system are fully described in the bulletin.

REFRACTORIES — "Refractories for Power Plants," a booklet recently issued by Charles Taylor Sons Company, of Cincinnati, Ohio, contains, in a concise form, considerable information on fireclay brick for boiler settings. Data on shrinkage, deformation, slag erosion, spalling, etc., are contained in the booklet.

COATING MACHINE — The Metals Coating Company of America, Philadelphia, Pa., has issued a new catalog on its metal-coating machine. "Metalayer," picturing the services rendered by this tool (building metal surfaces and protecting against corrosion).

AUTOMATIC CONTROL VALVE — Both the motor-operated and the magnetic types of automatic electric control valves are described in a twenty-page booklet lately published by The Bristol Company, of Waterbury, Connecticut. In addition to description of automatic valves for air, gas, water, oil, and steam for various types of ovens and furnaces, recording thermometers and pyrometers are also illustrated and described.

TRACYFIER — The Pipe Line Tracyfier, an instrument for separating any liquid and solid particles from any gas or vapor, is discussed in Bulletin 1047, recently issued by the Andrews-Bradshaw Company, Farmers Bank Building, Pittsburgh, Pa. Mechanical details of the Pipe Line Tracyfier, which, it is claimed, will deliver 100 per cent dry, clean steam when installed in a saturated steam line, are shown by drawings in the bulletin.

STOKERS—A booklet describing the new type high capacity Taylor stoker, of which five are being built for the Detroit Edison Company, has been published by the American Engineering Company, of Philadelphia, Pa. Numerous illustrations of the new automatic stokers add interest to the description.

RECTIFIERS—The Kodel Electric and Manufacturing Company has issued several pamphlets describing their improved copper-oxide "kuprox" rectifiers. Technical data regarding physical and electrical characteristics, clarified by graphs and oscillograms, and specifications of rectifiers for battery charging, telephone and telegraph service and time clock signal and recording systems are treated in the bulletins.

FLEXIBLE COUPLINGS — Bulletin E-1054, issued by the De Laval Steam Turbine Company, of Trenton, N. J., describes in detail the De Laval flexible coupling, of the rubber bushing type. Description of construction and instructions for installation are included.

FUEL PRICES

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$1.95 @$2.40
Kanawha	Columbus	1.25 @ 1.50
Smokeless	Cincinnati	1.75 @ 2.00
Smokeless	Chicago	1.75 @ 2.00
S. E. Kentucky	Chicago	1.35 @ 1.65
Steam	Pittsburgh	1.40 @ 1.75
Gas Slack	Pittsburgh	1.00 @ 1.10
Big Seam	Birmingham	1.50 @ 1.75
Anthracite (Gross Tons)		
Buckwheat	New York	$2.50@$2.75
Barley	New York	1.40@ 1.50

FUEL OIL

New York—July 18, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 5.25c. per gal.; 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—July 9, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.40 per bbl. or 42 gal.; 26@28 deg., $1.45 per bbl.; 28@30 deg., $1.50 per bbl.; 30@32 deg., $1.55 per bbl.; 32@36 deg., gas oil, 4.3c. per gal.; 38@40 deg., distillate, 5.25c.

Pittsburgh — July 9, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., 5.5c. per gal.

Philadelphia — July 10, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.575@$1.625 per bbl.; 23@27 deg., $2.10@$2.15 per bbl.

Cincinnati — July 16, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5.25c. per gal.; 30@32 deg., 5.5c. per gal.

Chicago—July 15, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 65c. per bbl.; 26@30 deg., 85c. per bbl.; 30@32 deg., $1.00 per bbl.

Boston — July 15, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.43c. per gal; 28@32 deg., 5.5c. per gal.

Dallas—July 13, f.o.b. local refinery, 26@30 deg $1.30 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif. Madera—Madera Irrigation Dist., plans the construction of a power distribution system, also transmission lines and stand-by steam plant in connection with proposed Friant dam.

Calif., Oakland—East Bay Municipal Utility Dist., J. H. Kimball, Secy., will receive bids until July 24 for furnishing and constructing high tension switch structure for Pardee Power plant, Mokelumne river project.

Calif., Watsonville — City plans an election soon to vote $134,000 bonds for waterworks improvements including new wells, pumping plants, etc. H. B. Kinchen, is city engineer.

Conn., Bridgeport—United Illuminating Co., F. Cutts, Mgr., 1115 Broad St., is receiving bids for additions to turbine and switch rooms on East Main St. Estimated cost $350,000. Westcott & Mapes, 139 Orange St., are architects.

Ill., Chicago—Commonwealth Edison Co., 72 West Adams St., awarded contract for masonry, etc., for a 1 story, 24 x 70 ft. sub-station at 1618-20 Prairie Ave. Estimated cost $20,000.

Ill., Chicago—J. T. Cuneo, 2242 Grove St., awarded contract for the construction of a 60 story office and stores building at 151-157 North Michigan Ave. to O. W. Rosenthal-Cornell Co., 228 North La Salle St. Estimated cost $8,000,000.

Ill., Chicago—I. P. Florsheim, 228 North La Salle St., is having sketches made for a 31 story office and stores building at Canal, Monroe and Clinton Sts. Estimated cost $12,000,000. Burnham Bros., 160 North La Salle St., are architects.

Ill., Riverside—Village is having plans prepared for waterworks improvements, including well and pumping station. Estimated cost $100,000. Marr, Green & Co., 400 North Michigan Ave., Chicago, are engineers.

Ky., Louisville—Southern Bell Telephone & Telegraph Co., T. H. Kettig, Local Supt. of Construction, 525 South 5th St., plans the construction of a 17 story office and telephone exchange at 6th and Chestnut Sts. Estimated cost $2,500,000. W. C. Spiker & Co., Forsyth Bldg., Atlanta, Ga., are consulting engineers.

Mich., Detroit—Michigan Bell Telephone Co., Cass Ave., is having plans prepared for the construction of a central warehouse and garage including steam heating system, boilers, elevators, etc., on Oakman Blvd. Estimated cost $1,500,000. Smith, Hinchman & Grylls, 800 Marquette Bldg., are architects and engineers.

Minn., Minneapolis—W. B. Foshay Co., 9th St. and Second Ave. S., awarded contract for the construction of a stores and office building at 8th St. between Marquette and Second Aves. to National Contracting Co., 311 Metropolitan Bank Bldg. Steam heating system, etc. will be installed.

N. J., Bogota—Mayor and City Council will receive bids until Aug. 8 for the construction of a pumping station, etc., in connection with sewage disposal works.

N. J., Passaic—W. Wilheim Co. Inc., 51 First St. plans a 1 story addition to power house. Estimated cost $40,000. Private plans. Work will be done by separate contracts.

N. Y., Binghamton—Our Lady of Lourdes Memorial, 160 Riverside Dr., plans the construction of a group of hospital buildings including nurses home, power plant, etc. Estimated cost $455,000. Murphy & Lehman, 108 Livingston St., Brooklyn, are architects. A. T. Lacey, Binghamton, is associate architect.

N. Y., Menands (mail Albany)—J. B. Lyon Co., Lyon Bldg., Albany, awarded contract for the construction of a printers building, including 81 x 88 ft. boiler house, etc., here, to Turner Construction Co., Graybar Bldg., New York. Estimated cost $1,000,000.

N. Y., New York—Julia O., Inc., 1292 Lexington Ave., plans the construction of a 21 story hotel at 1290 Lexington Ave. Estimated cost $1,200,000. Schwartz & Gross, 347 5th Ave., are architects.

N. Y., New York—W. J. Salmon, 11 West 42nd St., awarded contract for the construction of a 58 story office and stores building at 5th Ave. and 42nd St., to C. T. Willis, Inc., 285 5th Ave. Estimated cost $10,000,000.

N. Y., New York—Cornelius Vanderbilt, c/o Rude Realty Corp., A. S. Bing, in charge, 18 East 48th St., will build a 30 story office building, etc., at 501 Madison Ave. Estimated cost $1,000,000. F. Vitolo and R. Kohn, 56 West 45th St., are architects. Work will be done by separate contracts.

O., Zanesville—Ohio Power Co., Canton, subsidiary of American Gas & Electric Co., 30 Church St., New York, N. Y., is receiving bids for the construction of a power sub-station at National Pike here.

Pa., Philadelphia—U. S. National Realty Co., c/o Le Roy B. Rothschild, 249 South Broad St., Archt., plans the construction of a 25 story office building at 1924-34 Market St. Estimated cost $3,000,000.

Pa., Pittsburgh—Westinghouse Electric & Mfg. Co., East Pittsburgh, awarded contract for the construction of a sub-station at 54th and Butler Sts. to B. A. Groah Construction Co., 847 West North Ave., Pittsburgh.

Pa., Pittsburgh—J. L. Stuart, Consult. Engr., Oliver Bldg., will award separate contracts for a 15 story hospital, including power plant, etc., at North Ave. and Portersfield St., for Allegheny General Hospital. $6,000,000. York & Sawyer, 100 East 42nd St., New York, are architects. This corrects report in July 2 issue.

Tenn., Jackson—City plans an election Aug. 1 for vote $750,000 bonds for purchasing or building an electric light power and gas plant.

Tex., Galveston—Galveston Wharf Co., 2324 Ave. B, is having plans prepared for the construction of a grain elevator, 5,800,000 bu. capacity, including automatic fire pumps, electric power motors, etc., here. Estimated cost $2,000,000. Private plans.

Tex., Runge—Central Power & Light Co., Frost Bldg., San Antonio, have acquired a water and power plant here and plans extensions and improvements including new power machinery etc. Estimated cost $35,000. Private plans.

Va., Manassas—Bull Run Power Co., C. H. Wine, Secy., plans the construction of a power house, 240 hp. capacity. Equipment contracts awarded.

Wash., Centralia—City awarded contract for the construction of a dam, 200 ft. long, 8 ft. high and 46 ft. wide to divert the waters of the Nisqually river at a point six miles southeast of Yelm through a canal 9.6 miles for the development of 11,000 hp. in connection with municipal power project to E. T. Fisher, Centralia. Estimated cost $1,000,000. Project is scheduled for completion in June, 1930.

Ont., Niagara Falls—Hennepin Hotel Co., 1108 Royal Bank Bldg., Toronto, awarded contract for the construction of a hotel on River Rd. to J. W. Butler Co. Ltd, Royal Bank Bldg., Toronto. Estimaed cost $750,000. Steam heating system, elevators, etc. will be installed.

Ont., Toronto—Fairgrieve Ltd., 50 Dvrct. St., awarded contract for the construction of a boiler house to Goldie Construction Co. Ltd., 32 Church St.

Que., Sorel—Town Council, will soon award contract for the construction of a waterworks system including filtration plant, pumping station, etc. Estimated cost $150,000. A. Plamondon, 30 St. James St., Montreal, is engineer.

Que., Montreal—City is having plans prepared for the construction of an electric generating plant. Estimated cost $350,000. H. A. Terreauet is engineer.

Equipment Wanted

Boilers—E. H. Faile & Co., 441 Lexington Ave., New York, N. Y., Engrs., plan to purchase two boilers and other equipment for boiler plant of Clark Neighborhood House, 283 Rivington St., New York.

Boilers—U. S. Veterans' Bureau, Arlington Bldg., Washington, D. C., will receive bids until Aug. 6 for removal of existing boilers and installing complete five new boilers at U. S. Veterans' Hospital, Aspinwall, Sharpeburg, Pa.

Engine and Equipment—City of Tahlequah, Okla., plans the installation of a Diesel engine and equipment in municipal light plant. Estimated cost $25,000.

Pumping Equipment — City of Castlewood, S. D., will receive bids until Aug. 9 for pumping equipment, etc., for proposed waterworks improvements.

Turbine, Condenser and Engine — City of Wahoo, Neb., will soon receive bids for a 500 kw. turbine and condenser, also 500 kw. oil engine for proposed electric light plant improvements.

Industrial Projects

Conn., East Hartford (br. Hartford)—AIRPLANE FACTORY and POWER HOUSE—Pratt & Whitney Aircraft Co., 450 Capitol Ave., Hartford, awarded contract for foundation for a 2 story airlane factory including power house, etc., here. Estimated cost $2,000,000.

Conn., Hartford—SHEET METAL FACTORY—Liner-Atwell Co., 69 Bartholomew Ave., will soon award contract for a 2 story, 50 x 100 ft. factory for the manufacture of cornices skylights, ventilators, gutters and conductors Estimated cost $65,000. C. Malmfeldt, 15 Lewis St., is architect.

Ill., Rockford — FORGE FACTORY — Rockford Drop Forge Co., will soon award contract for the construction of a 1 story, 85 x 274 ft. factory. Estimated cost $150,000. Lockwood, Greene & Co., 400 North Michigan Ave., Chicago, are architects.

Ky., Louisville—METAL FACTORY—Reynolds Metals Co., 30th St. and Grand Ave., is having plans prepared for a 2 story, 90 x 100 ft. factory for the manufacture of tin, lead and aluminum foil on Hale Ave., $60,000. O. P. Ward, Lincoln Bldg., is architect; also first unit of factory for the manufacture of aluminum powder on Camp Ground Rd. A. G. Tafel, 140 South Third St., is architect.

Md., Baltimore—ASPHALT EMULSION FACTORY and BOILER HOUSE—American Bitumuls Co., R. H. Morton, V. Pres., 503 Market St., San Francisco, Calif., will build a 180 x 484 plant for the manufacture of asphalt emulsions including boiler house, etc.

Mich., Detroit — AIRPLANE PARTS FACTORY — Bohn Aluminum & Brass Co., Jos. Campau Ave., awarded contract for the construction of a 3 story, 110 x 145 ft. factory to Krieghoff Co., 6661 French Rd. Estimated cost $130,000.

O., Cleveland—FACTORY—Reliance Electric & Engineering Co., C. L. Collins, Pres., 1088 Ivanhoe Rd., awarded contract for a 1 story, 150 x 180 ft. factory to J. L. Hunting Co., Guarantee Title Bldg. Estimated cost $100,000.

O., East Liverpool—STEEL PRODUCTS FACTORY—Patterson Steel Products Co., awarded contract for the construction of a 100 x 180 ft. for the manufacture of forge and steel products to Potters Lumber Co., East Liverpool. Estimated cost $150,000.

O., Salem—AUTOMOBILE BODY FACTORY—Mullins Mfg. Co., plans the construction of a 1 story, 104 x 202 ft. factory for the manufacture of automobile bodies, radiators, steel motor boats, etc. on Depot St. Estimated cost $60,000. Private plans.

Pa., Philadelphia — BALL BEARING FACTORY—Hess-Bright Mfg. Co., Front and Erie Sts., awarded contract for a 1 story, 60 x 140 and 2 story, 60 x 182 ft. factory to F. V. Warren Co., 1913 Arch St. Estimated cost $100,000.

Pa., Philadelphia—UPHOLSTERY FACTORY—F. A. Bruner Inc., Canal and Hogan Sts., will soon award contract for the construction of a 4 story, 68 x 142 ft. factory for the manufacture of upholstery at Torresdale and K Sts. Estimated cost $170,000. L. Haupt, Jr. and R. N. Dippy, 1600 Walnut St., are architects.

Pa., Pittsburgh—U. S. Radiator Corp., Union Bank Bldg., awarded contract for the construction of a 1 and 2 story factory at 941 Behan St. to B. A. Groah Construction Co., 847 West North Ave. N. S. Estimated cost $65,000.

Tex., San Antonio—AIRPLANE FACTORY—Trust Co., c/o B. Hammond, c/o W. S. Forrester, Travis Bldg., Engr., plans the construction of a 2 story airplane factory, including machine shops, etc. Estimated cost $150,000. Owner not announced.

Ont., Guelph—STOVE PLANT ADDITION—Guelph Stove Co., York Rd., awarded contract for structural steel for a 1 and 2 story addition to plant. Estimated cost $200,000. W. A. Mahoney and A. Austin, 73 Quebec St., are architects.

Ont., Hamilton—BOTTLING PLANT—Coca-Cola Co. of Canada, 90 Broadview Ave., Toronto, plans the construction of a bottling plant, including steam heating system, etc., at Wellington and Wilson Sts., here. Estimated cost $100,000. Architect not selected.

Ont., Chippewa—TRANSMISSION and ELECTRICAL EQUIPMENT FACTORY — Canadian Ohio Brass Co., awarded contract for a 1 story factory for the manufacture of transmission and electrical lines to Smith Bros., 1740 Ellen Ave., Niagara Falls. Estimated cost $75,000.